Second International Rubiaceae Conference

Programme and abstracts

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E. Robbrecht, E. Smets
& C. Puff (eds.)

Second International Rubiaceae Conference (13-15 September 1995)

Programme and abstracts

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E. Robbrecht, E. Smets & C. Puff (eds.)

Second International Rubiaceae Conference (13-15 September 1995)
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	16h00	informal meeting (cafeteria; cash bar)
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	15h00	lectures EVO 3, 4, EVR 1
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Introduction

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INT 2 E. Smets *Wed 13, 10h40*
A commentary on the circumscription and evolution of the order Gentianales

INT 3 E. Robbrecht & P. De Block *Wed 13, 11h00*
Advances in Rubiaceae research 1993-1995

Theme 1. Evolution

Convener: Dr. L. Hufford (Washington State University, USA)

Relationships of Rubiaceae with other Gentianales

EVO 1 B. Bremer *Wed 13, 11h40*
Phylogenetic studies within Rubiaceae and relationships to other families based on molecular data

EVO 2 M. Endress-Fallen, B. Sennblad, S. Nilsson, L. Civeyrel, S. Huysmans, E. Grafström & B. Bremer *Wed 13, 12h15*
A phylogenetic analysis of the Apocynaceae s. str. and related taxa in the Gentianales — a multidisciplinary approach

EVO 3 B. Kendzior & H. Weber *Wed 13, 15h00*
Do the structural aspects of VAM-fungi in the roots of Rubiaceae indicate the relationship to the Gentianaceae?

EVO 4 S. Mészáros, J. De Laet & E. Smets *Wed 13, 15h35*
Phylogeny of Gentianaceae: a morphological approach

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EVO 6 F. Piesschaert, E. Robbrecht & E. Smets — The systematic position of *Dialypetalanthus*

EVO 7 C. Erbar & P. Leins — The formation of corolla tubes in Rubiaceae and presumably related families

EVO 8 T.B. Batygina & G.E. Titova — Embryology of the family Menyanthaceae in relation to its position in the system of the Gentianales

EVO 9 I.I. Shamrov — Ovule development and significance of its features for systematics of the Gentianaceae

EVO 10 V. Goethals & E. Smets — Seed coat anatomy in the Gentianaceae: systematic significance

Relationships within Rubiaceae

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EVR 2 K. Andreasen & B. Bremer *Thu 14, 09h30*
Phylogeny of the subfamily Ixoroideae

EVR 3 J.-F. Manen & A. Natali *Thu 14, 10h05*
Molecular phylogeny of the tribe Rubieae

EVR 4 A. Natali & J.-F. Manen *Thu 14, 10h40*
Comparison between molecular and morphological data in some selected taxa of Rubieae

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Proposed circumscription of the tribes Condamineeae, Catesbaeeae and Chiococceae based on morphological data (abstract p. 80)

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EVR 6 I. Schanzer — Morphological diversity and delimitation of species in herbaceous Rubiaceae (*Galium, Asperula, Ophiorrhiza*)

EVR 7 A. Elenevsky & S. Pjatunina — Relationships in the Rubieae, with special attention to *Asperula* and *Galium*

EVR 8 L.V. Gynda — Infraspecific differentiation of populations of *Galium album* in the eastern Carpathians

EVR 9 N.A. Mamedov — Two new species of *Asperula* for flora of Caucasus

EVR 11 R. Govaerts — World checklist of Rubiaceae (abstract not received)

Theme 2. Chemistry and Ethnobotany

Convener: Prof. Dr. K. Kubitzki (University of Hamburg, Germany)

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CHE 2 V. da S. Bolzani & O.R. Gottlieb *Thu 14, 12h10*
Indole alkaloids evolution in Rubiaceae

Posters:

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CHE 4 M.A.C. Kaplan, J.M.R. Figueiredo, M.R. de M.B. Borin & O.R. Gottlieb — Molecular mechanisms of evolution towards Rubiaceae

CHE 5 M.T. Sampaio-Santos, M.A.C. Kaplan & O.R. Gottlieb — Iridoids, systematic markers?

CHE 6 L.A. Nikolaeva — Comparative pharmacognostic studies on some producents of alkaloids in Apocynaceae

CHE 7 G.E. Titova & L.A. Nikolaeva — The possible pathways of preservation of Apocynaceae with high content of alkaloids

CHE 8 S.J. Ali (Shibli National College, India) — A contribution to the ethnobotany of Rubiaceae from India

CHE 9 T. C. Khánh — Medicinal plants of the family Rubiaceae in Vietnam and their use in the traditional medicine

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Convener: Prof. Dr. E. Robbrecht (National Botanic Garden, Belgium)

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PAL 6 D.B. Deb *unable to assist*
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Posters

PAL 2 M. Kiehn — Chromosomes of Pacific Rubiaceae

PAL 3 D.M. Bridson — *Ancylanthos* reconsidered

PAL 4 E. Robbrecht, S. Huysmans & E. Figueiredo The generic status of *Oxyanthus gossweileri* from Angola

PAL 5 S. Malcomber The status and evolution of *Trichostachys* (Psychotrieae)

PAL 7 R. Dutta (presented by C.E. Ridsdale) Sectional characteristics of Indian *Hedyotis* s.l.

PAL 8 B.C. Sabata Distribution patterns of rare and endangered Rubiaceae in Arunachal Pradesh (India)

PAL 9 Zhu Hua A study on the genus *Lasianthus* Jack from East Asia (China and Japan)

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Convener: Dr. C. Taylor (Missouri Botanical Garden, USA)

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NEO 2 H. Ochoterena-Booth *Fri 15, 10h10*
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NEO 3 T. McDowell *Fri 15, 10h45*
Biogeography and ecological specializations in the neotropical genus *Exostemma*: insights from a molecular phylogeny

Posters

NEO 4 C. Taylor – The generic delimitation of *Cruckshanksia* and *Oreopolus* (Hedyotideae)

NEO 5 C. Gustafsson – *Rosenbergiodendron* (Rubiaceae-Gardenieae) resurrected

NEO 6 N.M. Bacigalupo & E.M. Cabral – Infrageneric classification of *Borreria* (Rubiaceae-Spermacoceae) on the basis of American species

NEO 7 A. L. Prado & L.S. Kinoshita – Proposal for an infrageneric division in *Tocoyena*

NEO 8 L.S. Kinoshita & A.L. Prado – Patterns of distribution in *Tocoyena*

NEO 9 L. Macias – The genus *Manettia* in the Itatiaia National Park, Rio de Janeiro, Brasil

NEO 10 M.R. de V. Barbosa – The genus *Guettarda* in northeast Brazil

NEO 11 D. Zappi, J. Semir & N. Pierozzi – *Genipa infundibuliformis* (sp. ined.), a remarkable Brazilian species overlooked since 1889

NEO 12 E. Araujo da Anunciação & M.C.H. Mamede – Flora of the Serra da Juréia, São Paulo, Brazil: Rubiaceae

Theme 5. Biology and structure

Convener: Prof. Dr. C. Puff (University of Vienna, Austria)

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Inflorescence structure and diversification in the Rubiaceae

BIO 2 L. Ronse Decraene, E. Smets, R. Rutishauser & I. Mendoza-Heuer *Fri 15, 12h15*
Theligonum cynocrambe. The developmental morphology of a peculiar rubiaceous herb

BIO 3 C. Puff, E. Robbrecht, R. Buchner & P. De Block *Thu 14, 18h30*
A survey of secondary pollen presentation in the Rubiaceae

BIO 4 V. Negrón-Ortiz *Fri 15, 14h30*
Pollen dimorphism and mating systems of *Ernodea* in the Carribean Basin

BIO 5 J.E. de Araujo Mariath *Fri 15, 15h05*
Ovule and suspensor evolution in the Rubiaceae

BIO 6 S. Huysmans, G. El-Ghazaly, S. Nilsson & E. Smets *Fri 15, 16h00*
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Posters

BIO 7 A. Faivre & M. Clauss — A phylogenetic perspective on heterostyly and growth habit within Rubiaceae

BIO 8 H. Beeckman & S. Jansen — Growth rings in wood of tropical Rubiaceae

BIO 9 L. Vrydaghs, H. Doutrelepont & H. Beeckman — Phytoliths in wood of tropical Rubiaceae

BIO 10 S.M. Pire — Studies on the pollen of South American species of *Borreria* (Rubiaceae-Spermacoceae)

BIO 11 P. De Block — Pollen morphology of the tribe Pavetteae

BIO 12 S. Huysmans, E. Robbrecht & E. Smets — Pollen morphology of the Isertieae (Cinchonoideae-Rubiaceae) and systematic implications

BIO 13 S. Jansen, E. Robbrecht & E. Smets — Endexine ornamentation in pollen of Psychotrieae (Rubiaceae-Rubioideae)

BIO 14 E. Robbrecht & S. Huysmans — Kamiel Vermoesen, a pioneer in systematic palynology

Abstracts

The abstracts are arranged in the order of the programme. At the moment of printing, a number of contributors were still uncertain about their participation. All abstracts submitted are included, however.

E. Robbrecht, E. Smets & C. Puff (eds.)
2nd Int. Rubiaceae Conf., Progr. & Abstr.
Scripta Bot. Belg. **11**

INT 2

A commentary on the circumscription and evolution of the order Gentianales

Erik SMETS, Laboratory of Plant Systematics, K.U. Leuven, Belgium

Current knowledge of the position and circumscription of the Gentianales sensu lato is summarized. A comparison of the most important systems of classification shows that the Loganiaceae, Gentianaceae, Apocynaceae and Asclepiadaceae are generally recognized as principal families of the Gentianales, eventually completed with Rubiaceae, Menyanthaceae and some minor families of which the systematic position is still problematic.

Based on recent literature of morphological, phytochemical and macromolecular data a survey is given of the relationships and phylogeny of the Gentianalean families. From these insights, a new classification for the Gentianales sensu lato is proposed.

INT 3

Advances in Rubiaceae research 1993-1995

Elmar Robbrecht & Petra De Block
National Botanic Garden of Belgium

A review is made of macrosystematic contributions to the Rubiaceae in the time that has elapsed since the first International Conference on the Systematics of the Rubiaceae (Missouri Botanical Garden 1993) and the publication of the volume 'Advances in Rubiaceae Macrosystematics.'

Other advances in Rubiaceae research are also surveyed (floras, revisions and monographs; reproductive biology; DNA; phytochemistry).

E. Robbrecht, E. Smets & C. Puff (eds.)
2nd Int. Rubiaceae Conf., Progr. & Abstr.
Scripta Bot. Belg. **11**

EVO 1

Phylogenetic studies within Rubiaceae and relationships to other families based on molecular data

Birgitta BREMER, Department of Systematic Botany, Uppsala University, Sweden

Four hierarchical organized questions are asked about the Rubiaceae and their phylogeny. 1) Is the family Rubiaceae well supported as monophyletic? 2) What is the position within the angiosperm system, or which are the closest relatives? 3) Can or should one recognize subfamilies and what is the support for these? and finally Rubioideae 4) Which, or how many, tribes should be recognized in the subfamily Rubioideae? These issues are discussed starting from molecular data with references to earlier classifications and recent morphological analyses. From the subfamily Rubioideae new *rbc*L sequences of earlier not molecularly investigated genera are analyzed, e.g., from *Agatisanthemum, Carphalea, Cephaelis, Chasallia, Conostomium, Damnacanthus, Geophila, Kohautia, Manettia, Michella, Myrmecodia, Neurocalyx, Opercularia, Pentanisia, Pentanopsis, Pentodon, Phyllis, Placopoda, Plocama, Relbunium, Richardia,* and *Spermacoce*.

Ever since natural classification systems were presented, the Rubiaceae [Jussieu, Genera Plantarum (1789)] have been accepted as a natural or monophyletic family. Long before the family was recognized several species and/or genera were known [απαριυη - *Galium aparine,* Theophrasthus, Enquiry into Plants (ca 300 BC)]; in Linneaus' Species Plantarum [1753] more than 20 genera are listed, but due to the different arrangements of the stamens, they were placed in as many as six different classes (Tetrandria, Pentandria, Hexandria, Dioecia, Monoecia). With the exception of a few disputed genera the family is today accepted as a monophyletic family supported in cladistic analyses of morphological and molecular data.

Jussieu [Genera Plantarum (1789)] placed the family close to Dipsacaceae and Caprifoliaceae. This placement was followed into our century until Utzschneider [Mitt. Bot. Staatss. München 3: 96-98 (1951)] and Wagenitz [Bot. Jb. 79: 17-35 (1959)] suggested a position close to or within Gentianales. However, already Endlicher [Enchiridion Botanicum (1841)] indicated affinities between Rubiaceae and Loganiaceae of the Contortae (=Gentianales). After Wagenitz most systematists accept Rubiaceae within Gentianales except Cronquist [An Integrated System of Classification of Flowering Plants (1981)] who keeps the family in the order Rubiales putatively in-between Gentianales and Dipsacales. A position in or close to Gentianales, however, is supported by cladistic analyses of molecular data.

Rafinesque [Ann. Gén. Sci. Phys 6: 76-89 (1820)] was the first author who classified the genera into subfamilies. He used over ten different subfamilies of which several include non-Rubiaceae taxa, e.g., members of Caprifoliaceae and Dipsacaceae. Modern Rubiaceae taxonomists have accepted two [Verdcourt, Bull. Jard. Bot. Brux. 28: 209-281 (1958)], eight [Bremekamp, Acta Bot. Neerl. 15: 1-33 (1966)], or four subfamilies [(Robbrecht, Opera Bot. Belgica 1: 1-271 (1988)], respectively. Cladistic analyses of molecular and morphological data support three main groups more or less corresponding to the subfamilies Rubioideae, Ixoroideae, and Cinchonoideae, however differently circumscribed than previously.

More than 25 tribes including genera associated with the subfamily Rubioideae have been described. Modern Rubiaceae taxonomists accept 18 (Verdcourt), 19 (Bremekamp), or 16 tribes (Robbrecht), respectively. Molecular investigations, unfortunately not including members of all tribes described, shows that several of the "accepted" tribes are non-monophyletic; the easiest and perhaps most informative solution is to lump together several tribes of the Rubioideae.

EVO 2

A phylogenetic analysis of the Apocynaceae s.str. and some related taxa in the Gentianales A multidisciplinary approach

*Mary E. Endress (Institute of Systematic Botany, Zürich, Switzerland), Bengt Sennblad (*University of Uppsala, Sweden) Siwert Nilsson (**Palynological Laboratory, Stockholm, Sweden), Laure Civeyrel (Royal Botanic Gardens Kew, England), Suzy Huysmans (K.U. Leuven, Belgium), Elisabeth Grafström (**) & Birgitta Bremer (*)*

The Apocynaceae s.str. has customarily been divided into two subfamilies. The *Plumerioideae* is considered to be the more primitive, the Apocynoideae advanced, with many characters in common with the Asclepiadaceae. A number of characters define the Apocynoideae as a homogeneous group. In contrast, the Plumerioideae are extremely heterogeneous, and can be divided into nine more-or-less well defined tribes. Inter-tribal relationships of the family are complex, and existing classifications are based almost exclusively on the same few morphological characters. In this study nucleotide sequence data from the plastid rbcL and matK genes is analyzed together with morphological data from floral structure and pollen. Fourteen genera of Apocynaceae, including at least one representative each of the eleven tribes currently recognized, are compared with one representative each of the four tribes Loganiaceae, Gelsemieae, Strychneae and Plocospermeae of Loganiaceae s.l., one representative each of the tribes Coptosapelteae, Cinchoneae and Gardenieae of the Rubiaceae, and *Gentiana* (Gentianaceae). The results are presented in a combined cladistic analysis in order to provide a more precise phylogeny of the family.

E. Robbrecht, E. Smets & C. Puff (eds.)
2nd Int. Rubiaceae Conf., Progr. & Abstr.
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EVO 3

Do the structural aspects of VAM-fungi in the roots of Rubiaceae indicate the relationship to the Gentianaceae?

Bernd KENDZIOR and Hans Christian WEBER
Morphologie und Systematik der Pflanzen, Fachbereich Biologie der Philipps-Universitat Marburg, 35032 Marburg, Germany

The roots of most flowering plants are able to be colonized by VAM-fungi In most plant families their pattern of colonization is similar after penetration, the hyphae almost homogenously colonize the root cortex by intercellular running hyphae. Short hyphae, ramifying from the intercellular running hyphae, infect cortex cells intracellularly, mostly developing a single arbuscle which often entirely fills out the cell volume. Vesicles are produced on intercellular hyphae either intercalarly or teminally.

In contrast, the pattern of VA mycorrhizae in the Rubiaceae is remarkably different, although the root fungi belong to the same species. The hyphae penetrate the root through short cells of the exodermis Further colonization only continues intracellularly from cell to cell Whithin the cells the hyphae undergo intense coiling, resulting in dense hyphae glomerules Due to the intracellular growth, a fungal root infection is restricted to clusters of infected cortex cells Since intercellular hyphae are missing, vesicles also are intracellular. Inside the infected cortex cells several small arbuscles may develop on short hyphae, ramifying from the coiled intracellular hyphae

This pattern of colonization is characteristic also for the Gentianaceae and their related families. The aberrant habit was called 'structural incompatibility' by Demuth & Weber [Angew Bot 64: 247-252 (1990)]. Based on the similarity of the VAM-structures in Gentianaceae and Rubiaceae it is discussed, wether the structural incompatibility can be used as a feature to point out relationships between higher plants.

EVO 4

Phylogeny of Gentianaceae: a morphological approach

Sándor MESZÁROS, Research and Information Institute for Agricultural Economics, Budapest, Hungary

Jan DE LAET and Erik SMETS, Laboratory of Plant Systematics, K.U.Leuven, Belgium

The intrafamilial relationships of the Gentianaceae are investigated by means of a cladistic analysis based on morphological and to a lesser extent on chemical data. The 21 genera that are selected for the analysis represent all tribes and subtribes of Gilg [*In* Engler and Prantl, *Die natürlichen Pflanzenfamilien 4, 2: 50-108* (1895)] except Leiphaimeae, Voyrieae and Rusbyantheae. The large genus *Gentiana* is represented by three of its sections. The former Loganiaceous genera *Anthocleista* and *Fagraea* are used as outgroups. Standard parsimony analyses and analyses using weighting schemes based on the cladistic reliability of the characters give congruent results as far as the global relationships are concerned.

The best supported clade contains *Eustoma* (Tachiinae) and all included Gentianinae, Erythraeinae and Chironiinae. The basal division in this clade is between *Ixanthus* and the other genera. In this way *Ixanthus*, an endemic of the Canary Islands, connects the mostly woody tropical and the mostly herbaceous temperate taxa. The subtribe Gentianinae (excluding *Ixanthus*) is monophyletic, while Erythraeinae and Chironiinae are not monophyletic. In most analyses, however, both subtribes (and including *Eustoma*) constitute the sister-group of the Gentianinae, possibly Erythraeinae, Chironiinae and *Eustoma* should be merged.

The basal parts of the cladograms, involving the woody tropical representatives and *Exacum*, are poorly resolved. More extensive sampling, especially among the tropical representatives, is necessary to elucidate these basal relationships.

The tropical ancestry of the family, the switch from a woody to a herbaceous life form, and the position of critical taxa such as *Swertia* and *Halenia* or *Tripterospermum*, are discussed. As for the chemical characters, it is concluded that xanthone oxygenation patterns are useful characters for elucidating relationships at this taxonomic level.

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EVO 5

The Loganiaceous connection of the family Rubiaceae

Shashikala Kshetrapal
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Jaipur - 302 004, India

Studies on the floral anatomy of species representing all the families of the Gentianales and the family Rubiaceae shed a flood of light on the origin and relation of the latter. The almost unique character of the Rubiaceae is the presence of interpetiolar stipules. Outside the Rubiaceae, this character has been found to occur in the subfamily Buddleioideae of the family Loganiaceae. Like the Rubiaceae, the interpetiolar stipules in the Loganiaceae are vascular.

In the possession of the following common characters, the Rubiaceae offer a point of contact with the family Loganiaceae, especially subfamily Buddleioideae : (1) Leaves arranged in opposite-decussate manner, (2) presence of interpetiolar stipules, supplied by vascular traces from the marginal traces of the leaves, (3) stamens, as many as and alternating with the petals, (4) gynoecium consisting of two or more united carpels; when bicarpellary, the two carpels median or lateral in position, (5) placentas in the Loganiaceae and the subfamily Cinchonoideae of the family Rubiaceae. T-shaped and with many ovules in each loculus.

An additional point of unexceptional value is the presence of glandular squamellae in certain Rubiaceae, such as *Hamelia patens* and others, similar to structures which are found, not only in the family Loganiaceae but which are of widespread occurrence in the order Gentianales. Moreover, the genus *Mitreola* with its half-inferior ovary effectively fills up the gap between the Loganiaceae and the lower Rubiaceae which too have a half-inferior ovary.

Further, a comparative study of the various taxa in the family Loganiaceae and the Rubiaceae reveals different stages in the adnation of vascular traces of the different floral cycles inside the outer wall of the inferior ovary which is undoubtedly of appendicular in nature in both these taxa.

EVO 6

The systematic position of *Dialypetalanthus*

Frederic PIESSCHAERT, Laboratory of Plant Systematics, K.U.Leuven, Belgium

Elmar ROBBRECHT, National Botanic Garden of Belgium

Erik SMETS, Laboratory of Plant Systematics, K.U.Leuven, Belgium

Since the literature on *Dialypetalanthus fuscescens* Kuhlm., the only representative of the familiy *Dialypetalanthaceae*, is limited and contains a number of discrepancies, a correct description and illustration of this species proved to be necessary to obtain a proper judgement about its possible relationships. In the past, *Myrtales* (viz. *Trapaceae*, *Lythraceae*, *Onagraceae*, *Melastomataceae*, *Myrtaceae*, *Rhizophoraceae*), *Gentianales* (viz. *Loganiaceae*, *Rubiaceae*), *Rosales* and *Cornales* were suggested to be closely related to *Dialypetalanthus*.

Dialypetalanthus fuscescens is endemic in the Amazonian region, but it is not restricted to Brazil, the species is also found in Bolivia and Peru. Its centre of distribution is not situated in eastern Brazil, as previously suggested, but in the border region between Brazil and Bolivia.

Morphological and anatomical observations of herbarium specimens revealed the following:

- The large, leaf-like stipules make up the most conspicuous vegetative character. They are connected at their bases to form a low stipular sheath.
- The wood is characterized by septate libriform fibres, filled with silica bodies. Scanty paratracheal parenchyma is present.
- Flowers are arranged in indeterminate thyrsi.
- Stamens are united at their base into a short androecial ring. The anthers possess crystalline appendages (Ca-oxalate packages) at their apex, the function of which is unclear; most likely, these appendages are involved in a pollination strategy. The anthers open with a longitudinal slit and not through apical pores, as suggested by several authors.
- The solid flower structure gives reason to believe that *Dialypetalanthus* is beetle-pollinated.
- Placentation is axile in the lower part of the ovary and parietal in the upper part.
- The calyx and corolla are initiated as dimerous whorls.
- Endocolpi of the pollen grains may be provided with transverse connections.

In the vegetative stage, *Dialypetalanthus* is hardly distinguishable from certain *Cinchonoideae* (*Rubiaceae*). The well-developed endosperm, buds that are protected by stipules instead of bud scales, numerous unitegmic ovules, paracytic stomata and reticulate thickenings of the inner tangential walls of the exotesta equally suggest a relationship between both taxa. However, the presence of free petals, dimerous floral whorls, cantharophily (?) and polyandry are considered to be arguments for establishing a new order *Dialypetalanthales*, closely related to the *Rubiales* s.str., and set apart from the *Gentianales*.

However, a floral ontogenetic investigation is still missing by lack of material and could throw more light on the relationships of *Dialypetalanthus*.

E. Robbrecht, E. Smets & C. Puff (eds.)
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EVO 7

The formation of corolla tubes in Rubiaceae and presumably related families

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In recent systems, the Rubiaceae are included in or (as a separate order) next to the Gentianales. Within the latter order, the Loganiaceae are often regarded as closest related and ancestral to the Rubiaceae. Recently Erbar [*Bot. Jahrb. Syst.* 112: 417-451 (1991)] has tested a new character within the Asteridae s.l., namely the ontogeny of sympetaly. It could be shown that the character states "early" or "late sympetaly" (under critical evaluation and in comparison with other characters !) provide a valuable feature for a natural classification of this group. Applying this character to the Rubiaceae and the Gentianales s.str., we state "early sympetaly" in the Rubiaceae and "late sympetaly" and transitions between "early" and "late sympetaly" in the families of the Gentianales s.str. ["late sympetaly": Loganiaceae (*Spigelia*), Apocynaceae, Gentianaceae p.p.; "transitions": Asclepiadaceae, Gentianaceae p.p.]. We conclude that the Gentianales as the whole are ancestral within a great part of the Asteridae s.l. If we assume that the Rubiaceae have evolved from Loganiaceae (or any other family of the Gentianales s.str.), "early sympetaly" must be derived from "late sympetaly" in this case. Parallelly the Oleales (also a typically "early sympetalous" group) appear to be linked with the Gentianales.

EVO 8

Embryology of the family Menyanthaceae in relation to its systematic position in the Gentianales

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The question of systematic position of Menyanthaceae in Gentianales and its interrelationships remains to be on discussion (Torne, 1983, 1992; Wagenitz, 1977; Cook, 1978; Cronquist, 1981; Dahlgren, 1984, 1989; Ehrendorfer, 1983; Takhtajan, 1987 and oth). The analysis of original and literature data on embryolgy of Menyanthaceae representatives permitted to make its embryological characterstics. **Anther** is tetrasporangiate, development of microsporangium wall is of dicotyledonous-type, the formed anther wall consists of 4-5 layers, the mature anther wall - of 2 layers; **tapetum** is cellular, di-polynuclear, polyploid, without reorganization, with orbicles; **microspore tetrads** are tetraedral and isobilateral, are formed simultaneously; **mature pollen** grains are three-furrouwed-porous, 2-and 3-cellular, with big amount of starch. **The ovules** are anatropous, tenuinucellate, unitegmic, with **endothelium** (the cells have thickened walls), **hypostase; funiculus** is short, the **vascular bundle** with the elements of spiral vessels go to integument, reaching micropyle; single **archesporial cells** trantorms directly to megasporocyte; **megaspore tetrads** are linear, T-formed and isobilateral; the **embryo sac** is of Polygonum-type. **Antipodes** are ephemeral, sometimes cells are not formed (*Nymphoides peltatum, N. humboldtianum, N. cristatum*). **Fertilization** is porogamous; **endosperm** cellular, is present in the mature seed; **embryogenesis** is of Asterad-type Senecio-variation; **embryo** is direct, small, differentiated to organs, disposed in the seed centre. In the **mature seed** there are stores of proteins and lipids. **Apogamety** is noted.

The complex of some **embryological features** in the structure of particularly **female generative sphere and the seed (cellular endosperm, Asterad-type of embryogenesis, well developed vascular bundle in integument, typical endothelium and others)** coincides with the opinion of authors, who **apportion Menyanthaceae family from the order Gentianales** (Yamazaki, 1974; Thorne, 1992; Cronquist, 1981; Cook, 1978; Bohm et al., 1986; Dahlgren, 1989; Nicholas, Baijnath, 1994; Gustafsson, Bremer, 1995;). Takhtajan (1995, oral communication) proposes to make Menyanthaceae into a separate order Menyanthales. However, the number of another embryological features, mainly in **male generative sphere**, direct to certain similarity with some families of this order. The relation of embryological data "for" and "against" including of Menyanthaceae in Gentianales is about 50% and in accordance with that on morphological, anatomical, biochemical etc. features (Airy Shaw, 1985; Brummitt, 1992; Nicholas, Baijnath, 1994). This brings difficulties for the final question solution.

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EVO 9

Ovule development and significance of its features for systematics of the Gentianaceae

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5 species belonging to 4 genera (*Gentiana*, *Gentianella*, *Gentianopsis*, *Swertia*) are embryologically studied.

OVULE DEVELOPMENT. The gynoecium is paracarpous (not syncarpous) , from two carpels. Ovary is superior and unilocular. Ovules develop spirally on 4 parietal placentae. One placental vascular bundle runs to each ovule, without entering it. The ovular primordium consists of epidermal and subepidermal layers and axial cell row under archesporial cell. It arises due to periclinal divisions of cells in third-fourth layers of placenta. The ovule is tenuinucellate and unitegmic. Nucellus is presented by epidermal cells and is destroyed during early stages of embryo sac development. Integument is of epidermal origin, with specific two-layered integumentary tapetum. The latter has narrow cells elongated in tangential direction. Proteins and dextrines are accumulated in these cells. Under embryo sac the hypostase is differentiated. Its cell walls show a strong PAS+ reaction. The chalaza is normal. The vascular band of procambial cells is formed in raphe. Archesporium is one-celled, transforms into megasporocyte without parietal cell formation. Megaspore tetrad is linear. The embryo sac develops from chalazal megaspore by Polygonum type.

OVULE FEATURES FOR SYSTEMATICS. Ovule type: anatropous - *Gentiana cruciata*, *G.lutea*, *Gentianopsis barbata*, ana-campylotropous - *Swertia iberica* , hemitropous - *Gentianella lingulata*. Integument (number of layers): 5-7 - *Gentianella*, *Gentianopsis*, 8-10 - *Gentiana cruciata*, 15-20 - *Gentiana lutea*, *Swertia*. Funiculus : almost absent in all species, besides *Gentianella*. Hypostase (number of layers): 1 - *Gentiana*, 2-3 - *Gentianella*, *Gentianopsis*, 4-5 - *Swertia*. Embryo sac : oblong in all species and ovoid in *Gentianella*. Antipode structure and number : diploid in *Gentiana lutea* (3), *G.cruciata* (6), *Gentianella* (9-12), octoploid in *Swertia*(3) and polyploid in *Gentianopsis* (3). Substance accumulation : in archesporial cell , megasporocyte and embryo sac more starch in *Gentiana* and more proteins in *Swertia*.

An evaluation of the data obtained suggests there are many differences between genera *Gentiana* and *Swertia*. Besides, point of vue about of making *Gentianella* into a separate genera from *Gentiana* s.l. is confirmed.

EVO 10

Seed coat anatomy in the Gentianaceae: systematic significance

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Gentianaceae, like most unitegmic sympetalous taxa, have exotestal seeds [Corner, *The seeds of dicotyledons*, Cambridge University Press, Cambridge (1976)]. In Gentianaceae the outer layer of the seed coat provides the main diagnostic characters.

Seed anatomical knowledge of Gentianaceae is scanty although the existing morphological data show that seed coats do have systematic value. The diversity in exotestal cell shape and cell wall thickenings of the radial and inner tangential walls can be of great help for systematics at the specific and generic level. The first and also the most complete investigation on the use of seed coat characteristics in the taxonomy of Gentianaceae is that of Guérin [*J. Bot.* 18: 33-52, 83-88 (1904)]. Netolitzky [*Anatomie der Angiospermen Samen*, Gebrüder Borntraeger, Berlin (1926)] presented an excellent review of all available data until 1923, relevant to the development and structure of seed coats. Since the use of the scanning electron microscope (SEM) the number of studies concerning the seeds of Gentianaceae has increased considerable but these investigations were mostly restricted to the external seed micromorphology. The most recent work on the seed anatomy of the Gentianaceae since Guérin (1904) is that of Bouman & Schier [*Acta Bot. Neerl.* 28: 467-478 (1979)].

The aim of this study is to characterize the different seed types in the Gentianaceae at the generic level, with special emphasis on the seed coat anatomy. Both the seed micromorphology and the seed anatomy of the type species of the genera studied are observed by SEM. In mature seeds the outer cell walls may be collapsed and may touch the radial walls and the bottom of the cell, so that thickenings become visible. SEM examinations only offer information on sculpture patterns of thickenings when the outer tangential wall is withered, or when the wall is artificially removed. Removal of the outer tangential walls can be effected by maceration in water followed by ultrasonic cleaning. The treated seeds of the different genera reveal all kinds of lignified thickenings on the anticlinal and inner tangential cell walls (annular, pitted, reticulate, tuberculate,). Exotestal cell size and shape differ a great deal when the genera studied are compared.

The formation of annular thickenings on the anticlinal walls of the exotesta is a common feature within the order Gentianales [see also Guerin (ibid. 1904)]. It is found in Gentianaceae, but also in Loganiaceae, Apocynaceae, Asclepiadaceae and Rubiaceae [Bouman & Schier (ibid. 1979), Robbrecht & Puff, *Bot. Jahrb. Syst.* 108: 63-137 (1986), Somers, *Bull. Jard. Bot. Nat. Belg.* 58: 47-75 (1988)]. This type of thickening is rather rare in dicots and not common in other sympetalous families.

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EVR 1

Phylogeny and circumscription of the tribe Isertieae

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The tribe Isertieae as circumscribed by Robbrecht [Opera Bot. Belg.1: 182 (1988); 6: 176 (1993)] is morphologically unusually diverse. It contains genera that are raphidiate as well as exraphidiate, that have heterostylous as well as monomorphic flowers, normal valvate as well as induplicate, reduplicate, contorted or imbricate corolla aestivation, colporate as well as porate pollen, capsular as well as drupaceous and baccate fruits, etc. It is highly suspect of being polyphyletic, as was also indicated by a recent cladistic study [Rova & Andersson, Nord. J. Bot.15 (in press)] A cladistic analysis was therefore performed, including representatives of all genera referred to the Isertieae by Robbrecht, plus representatives of other tribes segregated from the Isertieae by Bremekamp [Acta Bot. Neerl. 15: 1—33 (1966)] and M.C.G. Kirkbride [Brittonia 31: 313—332 (1979); Revta. Brasil. Bot. 4: 119—123 (1981)]. Also included in the analysis were representatives of most other tribes of the family.

It is concluded that all raphidiate genera (*Gouldia, Indopolysolenia, Keenania, Lecananthus, Leucocodon, Mycetia,* and *Ophryococcus*) should be transferred to the Rubioideae s. lat. Because few genera of the Rubioideae were included their positions within this subfamily are partly uncertain, as is the exact delimitation of the subfamily. It is suggested that *Gouldia* and *Mycetia* may be closely related to the Hedyotideae and that *Lecananthus* and *Leucocodon* may be close to the Schradereae. *Ophryococcus* should be included in the genus *Hoffmannia*, as suggested already by Kuntze [Rev. gen. pl. 1: 285 (1891)]. The genus *Aoranthe* belongs to the Gardenieae. *Gonzalagunia* may be related to *Rondeletia* or *Sipanea*. *Raritebe* is of uncertain affinity but not closely related to *Isertia*.

The remaining genera come out as two major clades. One of these includes, in addition to *Isertia*, *Mussaenda* and its close relatives *Aphaenandra, Heinsia, Neomussaenda, Pseudomussaenda*, and *Schizomussaenda*. Within this clade, there is a basal dichotomy between the neotropical genus *Isertia* and the paleotropical *Mussaenda* group. The branch uniting *Isertia* to the *Mussaenda* group is not well supported. *Yutajea* is nested within the genus *Isertia* and should be reduced to synonymy. The second major group comprise the genera *Acranthera, Amphidasya, Ecpoma, Pentaloncha, Pseudosabicea, Schizostigma, Stipularia*, and *Temnopteryx*. It is suggested that this group is recognized as a separate tribe, for which Bremekamp's tribal name Sabiceeae must then be used. The genus *Pseudosabicea* in its present circumscription is probably a basal grade of a clade including *Schizostigma* and *Sabicea* s. str. *Pittierothamnus*, presently synonymized under *Amphidasya*, is not consistently clustered with the type of that genus and may merit recognition.

EVR 2

Phylogeny of the subfamily Ixoroideae

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Both combined and separate parsimony analyses of molecular and morphological data were performed. The molecular part is based on sequences of the chloroplast encoded gene *rbc*L. It includes almost fifty sequences, of which 40 are unpublished, representing four of the five Ixoroideae tribes, the Vanguerieae, and two outgroup taxa. The morphological data was mainly extracted from literature.

The congruency between the resulting trees from the two data sets is high, e.g. most of the included taxa from the tribe Pavetteae form a monophyletic group in both the morphological and the molecular analyses. There are, however, contradicting topologies and also a lack of resolution, e.g. within the Gardenieae-Gardeniinae, in the strict consensus trees of both the separate analyses.

The combined analysis results in shorter and fewer trees, and for parsimony reason the combined analysis represents the best phylogenetic hypotheses. The interrelationships of the Gardenieae-Gardeniinae, however, are not unequivocally established in this analysis.

The position of two problematic taxa is indicated; the genus *Posoqueria* is not a part of the subfamily Ixoroideae, but the genus *Bertiera* is. The tribal home for *Bertiera* seems to be a basal position in an extended Coffeeae.

The variation of the gene *rbc*L is surprisingly low in this morphologically very diverse subfamily. Further studies will therefore be concentrated on finding a more rapidly evolving gene to solve the present obscurities.

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EVR 3

Molecular phylogeny of the tribe Rubieae

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The previous studies on the phylogeny of the tribe Rubieae (MANEN & al. 1994, NATALI & al., 1995) have been extended to cover most of the genera and sections of the tribe. The chloroplast DNA sequences of the atpB-rbcL spacer have been analysed for approximatively 100 taxa, and the inferred phylogeny has been studied.
The addition of several taxa of the subfamily Rubioidae allows to determine the most probable sister group of Rubieae and to precisely define this subfamily by a large deletion bearing one of the atpB promoter. Moreover, the chloroplast rbcL gene itself and the nuclear rDNA internal transcribed spacer ITS1 have been sequenced in some selected Rubieae and Rubioidae taxa, and the respective inferred phylogenies have been compared.

EVR 4

Comparison between molecular and morphological data in some selected taxa of Rubieae

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A phylogenetic analysis of 15 selected taxa of the tribe Rubieae (Rubiaceae) was performed using morphological characters. The results were compared to the phylogenetic analyses of the same taxa based on the rbcL and the atpB-rbcL non-coding spacer sequences.
There are some discrepancies among the three analyses. The spacer tree seems more congruent with the phylogenetic analysis based on morphological characters than the rbcL tree.
This study also shows that the phylogenies based on DNA sequence comparison can be considered as an useful framework to re-examine some biosystematic characters, which are important for a better undestanding of the evolution of this tribe.

EVR 5

Phylogeny of the Gardenieae (Rubiaceae)

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The phylogeny of Gardenieae (Rubiaceae) is evaluated using 70 morphological and anatomical characters and 81 terminal taxa. After successive reweighting of the characters and modified bootstrap tests the following is concluded. The subtribe Diplosporinae does not belong in Gardenieae, and nor is *Posoqueria* a member of the tribe. Robbrecht & Puff's informal "tetrad group" is monophyletic. Likewise, their "*Alibertia* group" is supported as monophyletic, although slightly rearranged. On the other hand, their "*Aidia* group" has to be greatly expanded with several genera. The monophyly of this group, however, is weakly supported. Several disputed genera should be included in Gardenieae (*Anomanthodia*, *Amaioua*, *Brachytome*, and supposedly *Bertiera*). However, most inferred groups exhibit low bootstrap values and should, therefore, be viewed with caution.

EVR 6

Morphological diversity and delimitation of species in herbaceous Rubiaceae (*Galium*, *Asperula*, *Ophiorrhiza*)

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During studies of several taxonomically difficult groups of herbaceous Rubiaceae it appeared that they often possess similar problems. In *Galium* sect. *Orientigalium* of the Transcaucasus mountain region, in *Asperula* sect. *Cynanchica* of the S European Russia, and in West Malesian *Ophiorrhiza* similar patterns of geographical variability were revealed. Populations of the taxa in these groups are scatteredly distributed and isolated from each other by significant distances, mountain chains, outcrops of specific substrates like chalk or limestone, or different islands. This leads to much higher interpopulational variability of morphological characters compared to infrapopulational variability. Though differences are mainly of quantitative nature, many of the populations were described as separate, dubiously recognized, species.

In attempt to find out whether plants from different populations or ajacent geographical areas can be reliably distinguished and treated as separate taxa in spite of their similarity, or whether they possess an unseparable pattern of variability, the following procedure was practiced. All data available on morphological characters of specimens were registered in QUATTRO PRO electronic tables where primary data processing was carried out. Data on populations or geographically close groups of morhologilally similar specimens were averaged to produce separate tables for 'populations' used as OTU's. Variability of separate characters was assesed using STATGRAPHICS package. Data on specimens and populations were also analysed separately using cluster analyses in SYSTAT package. When clustering coincided with the geographical pattern of distribution, the OTU's were regarded as taxa. Finally corrected data on OTU's were transferred to DELTA package in attempt to separate taxa in question using traditional keys.

In all the three groups similar taxonomic and geographical pattern is revealed. There exist geographically variable and widely distributed species like *Galium hyrcanicum*, *Asperula graveolens* or *Ophiorrhiza cancscens* usually possessing a clinal pattern of variability in many separate quantitative characters. A number of closely related to them morphologically deviated endemics can be recognized as separate species scatteredly distributed through their areas, more often in marginal parts of the latter. Many of the previously described species should be reduced to synonyms.

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EVR 7

Relationships in the Rubieae, with special attention to Asperula and Galium

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Relationships between genera Asperula L.and Galium L. are corner-stone in the Rubieae taxonomy. The absence of definite distinctions leads to constant revision of the genera boundaries and accordingly its species composition. Different authors use the following characteristics for the genera differentiation: 1. corolla tube longer than lobes (Asperula) or shorter than lobes (Galium); 2. anthers and stigma included (Asperula) or exserted (Galium); 3. flowers with bracteoles (Asperula) or without bracteoles (Galium); 4. flowers sessile or with pedicels shorter than ovary (Asperula); flowers with pedicels longer than ovary (Galium); 5. fruits glabrous, pappilose, hairy but never uncinate-hairy (Asperula); fruits smooth, verrucose or rugose, glabrous to hairy, sometimes with hooked hairs (Galium). But all of these characteristics are not absolutely and sometimes relative species differ in some of them.

Thus G.pseudorivale Tzvel. (A.aparine Bieb.) differs from relative G.rivale (Sibth. et Sm.) Griseb. with long corolla tube. G.purpureum L. was transfered in genus Asperula by Ehrendorfer [*Flora Europaea* 4:14(1976)] according to the long bracteoles in spite of the fact this species has Galium-like corolla. Mediterranean G.verticillatum Dauth. has flowers with short pedicels and very small bracteoles. In the cases when the bracteoles and long corolla tube are considered to be the general characteristics of genus Asperula, it is perfectly unwarranted to transfer A.tinctoria L. in genus Galium [Scopoli, *Flora Carniolica*:101(177a); Gubanov et al., *Opredelitjel*:337(1991, in Russia)].

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EVR 8

Infraspecific differentiation of populations of *Galium album* in the eastern Carpathians

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The intra- and interpopulation variability of the morphological characters of *G.album Mill.* was evaluated. Also the distribution and habitat peculiarities were considered. Two subspecies are known in the Eastern Carpathians: *G.album subsp.album* and *G.album subsp.suberectum (Klokov) E.Michalkova* [Michalkova, Marhold: Karpatskaja flora: 78(1988)]. The first subspecies is rarely met at the glades or afterforest meadows in the lower mountain zone. The second one is distributed at the subalpine zone and differentiated by the shape of stem leafs and inflorescence.

The data on distribution, altitude, exposition, soil conditions and morfology supports the conclusion that the recently described subspecies of *G. album* is endemic for Eastern Carpathians and isolated geographicaly and reproductively from the related subspecies. The cushion-shaped life form was indicated.

The biometric analysis based on calculation of the measuring of charecters of stem, leaf, inflorescence and flower points out the low intrapopulation variability and considerable interpopulation variability.

Taking into consideration the biological species consept and the results of the multivariant analysis it is suggested that *G. album subsp. suberectum* forms a system of small isolated populations with substanable interpopulation variability on the rocky mountain tops of the Eastern Carpathians. The possibility to give the taxonomic status to one of them is doubtful.

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EVR 9

Two new species of *Asperula* for flora of Caucasus

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Two new species of genus *Asperula* L. for flora of Caucasus was collected and defined by the author in 1990 : *Asperula azerbaidjanica* N Mam., R Shach. et Sh.Velib. sp nov ,

A. aristata L.fil. (Botanical Journal of the Russian Academy of Sciences, v 78, 2, p 105-106(1993).

1) *Asperula azerbaidjanica* N. Mam, R. Shach. et Sh. Velib. sp. nov. - Planta perrēnis radice palari. Innovationes griiseo-virides, basi lignosar. Caules obtuse quadrangulares, prope basin ascendentes, 10-60 cm alti, in parte interiore papillis parvis tecti, supra subglabri Folia (10) 15-25(40) mm lg., 0.5-2 mm lt. Inflorescēntia paniculata, laxa. Bracteae liberae. Corolla 5-6 mm lg.,infundibuliformis, flavescenti-roseola, extra tuberculis vesicariis dense tecta; tubus corollae lobis 1.5-2-plo longior. Fructus 1.7-2.2 mm lg., tuberculis vesicariis parvis tectus, rubiginosus
Typus: Caucasus, Azerbaidjan planities demissa Samur-Diviczi in calcareis zonae maritimae, 20 .08.1990, N.A. Mamedov, R.T. Shachsuvarov, Sh.A.Velibecov (BAK, isotypus - LE).
Affinitas. Species *Asperulae aristatae* L.fil. proxima sed corolla minore tubo breviore, extra tuberculis vesicarilis dense testadiffert.
Habitat in calcareis denudatis zonae maritimae et in arenosis maritimis conchiferis.

2) *Asperula aristata* L. fil. - Caucasus , Azerbaidjan planities demissa Samur-Diviczi in zonae maritimae, in ruderatis, 18.08.1990, N.A.Mamedov,R.T.Shachsuvarov,Sh.A Velibecov (BAK) 18.08.1990, N.A. Mamedov, R.T. Shachsuvarov, Sh.A. Velibecov (BAK)

CHE 1

Morphologic and metabolic differentiation of Rubiaceae by latitudinal transitions

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Decrease in diversity of species from tropics to poles is considered "a true general principle of biology" [Wilson, *The Diversity of Life*, Harvard U. Press (1992)]. In contradistinction, for higher taxonomic levels, plant diversity in South America was observed to increase in the same direction. Moreover, for neotropical floristic inventories the pertinent areas along the expected simple latitudinal gradient were found to be distributed between discrete steps, separated by abrupt transitions. A major geographical disjunction of this type was found to occur at the rain-forest cerrado interface within the range of 10-15^0 southern latitude. A further disjunction was tentatively located at the central-plateau valley interface at 28-32^0 s.l. The transitions in plant habitat, in analogy to "phase transitions" [Gleick, *Chaos*, Penguin (1988)], are accompanied by changes in plant characteristics or taxons. Hence the interfaces must be endowed with evolutionary turbulence. These concepts [Gottlieb, Borin, Bosisio, *An. Acad. bras. Ci.*, in press (1995)] lead to an understanding of causes, locations and evolutionary mechanism of plant diversity, to be applied in the present lecture to the family Rubiaceae.

In areas of the rain-forest (0-10^0 s.l.) Rubiaceae (chiefly arboreous Ixoroideae and Cinchonoideae) rarely exceed 2.5% of the total number of angiosperm species, while in the central Brazilian highland savannahs (15-28^0 s.l.) the proportion reaches 5% (chiefly due to the presence of shrubby Rubioideae). This indicates lignification to block evolutionary development in the forest. In both interface regions by far the largest proportions of the relatively few Rubiaceae species belong to the Antirheoideae. From the chemical standpoint Ixoroideae, Cinchonoideae and Rubioideae are characterized by specific compositions, whereas each of the tribes of the subfamily Antirheoideae could be reclassified into one of the three traditional subfamilies, e.g. Guettardeae into Cinchonoideae. However according to Robbrecht [*Opera Bot. Belg.*, 1: 14 (1988)] from the morphological standpoint Guettardeae diverge sufficiently from Cinchonoideae to justify inclusion into a subfamily of its own. In this connection the predominant occurrence of Guettardeae in the intermediate, evolutionarily turbulent geographical ranges seems to be highly significant and illustrates an important phytogeographical principle: Morphological changes due to spatial radiation of lineages over habitat interfaces are accompanied only sluggishly by metabolic changes.

(Sponsored by CNPq, Brazil)

CHE 2

Indole alkaloids evolution in Rubiaceae

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Indole alkaloids constitute an excelent model for the value of biosynthetic sequences in dynamic chemosystematic studies. Biosynthesis comprises, from the simplest to the most complex alkaloidal types ten successive stages characterized by increasing variation of the terpenoid moiety. The simple non-rearranged groups based on strictosidine (I), corynantheine (II), rhynchophylline (III), akuammicine (IV) and stemmadenine (V), are followed by the rearranged types secodine (VI), quebrachamine (VII), aspidospermidine (VIII), vincatine (IX) and eburnamine (X). Rubiaceae are characterized by skeletal variation only of types I and II, besides the occurrence of unmodified type III. Apocynaceae are characterized by the variation of all types, diversifying chiefly types V-X. Loganiaceae, as Rubiaceae, only contain the unrearranged types I-IV, diversifying especially type IV. Indole alkaloids are able to distinguishneatly not only among these three families, but also, at lower hierarchic level among subfamilies, tribes or even groups of genera.

To illustrate only the case of Rubiaceae, only the presence of alkaloids in Cinchonoideae are of systematic relevance. Naucleae are distinguished from Cinchoneae by diversification of type I, in contrast to Cinchoneae which show strong variation only of type II. According to this criterion, Guettardeae, segregated into Antirheoideae by Robbrecht [*Opera Bot. Belg.* 1: 14 (1988)] fit into Cinchonoideae. Quantification of molecular parameters, such as skeletal specialization and oxidation level, confirm these observations and allow the construction of a plyletically meaningful dendrogram.

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CHE 3

Chemosystematic markers of Rubiaceae

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An examination of the distribution of secondary metabolites in Rubiaceae led to recognition of iridoids, indole alkaloids and anthraquinones as the predominant systematic markers of the three subfamilies Ixoroideae, Cinchonoideae and Rubioideae *sensu* Robbrecht [*Opera Bot. Belg.* 1: 1 (1988)], respectively. For these categories of compounds evolutionary advancement parameters based on the oxidation state of each of their representatives were calculated [Borin & Gottlieb, *Pl. Syst. Evol.* 184: 41 (1993)]. The pertinent averages of these values, together with the herbaceousness indices [Borin & Gottlieb, *Pl. Syst. Evol.* 184: 41 (1993)] were considered to characterize each of the subfamilies. The data were in good agreement with the classificatory system, except for Antirheoideae, the fourth of the author's subfamilies. The exclusive presence of iridoids in Vanguerieae suggests affiliation with Ixoroideae. The presence of iridoids and indole alkaloids suggests Guettardeae to occupy an intermediate position between Ixoroideae and Cinchonoideae. Only indole alkaloids characterize Cephalanteae, which consequently can be considered to belong to Cinchonoideae. Finally, anthraquinones suggest the close relationship of Knoxieae with Rubioideae.

Additionaly, phylogenetic progressions can be recognized through parallel changes of morphological characters and biosynthetic pathways to the selected categories of secondary metabolites mentioned above. The subfamily Ixoroideae, with an intermediate mean herbaceousness index can be considered the ancestral group. It synthesizes only iridoids suggesting affinity with Corniflorae. Further evolution, separates Rubiaceae into the more woody Cinchonoideae with indole alkaloids and the predominantly herbaceous Rubioideae that accumulate mainly anthraquinones.

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E. Robbrecht, E. Smets & C. Puff (eds.)
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CHE 4

Molecular mechanisms of evolution towards Rubiaceae (Asteridae)

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Dahlgren [Bot Notiser, 128. 119 (1975)] rearranged the most highly advanced families of the dicotyledons into iridoid and polyacetylene-sesquiterpene lactone bearing groups This seemed to suggest a polyphyletic origin for the Asteridae In opposition Cronquist [The Evolution and Classification of Flowering Plants, 2nd ed , New York Botanical Garden (1988)] considered Asteridae the most clearly characterized of the six subclasses of the dicots Worse, the presence of iridoids in apparently unrelated families, and, in contrast, the absence of iridoids from groups of typically iridoid containing lineages was considered to detract from the systematic importance of iridoids at higher levels of classification [Gershenzon and Mabry, Nord J Bot , 3 5 (1983)] However, conclusions based on presence/absence of phytochemicals are of little relevance in the evaluation of phylogenetic relationships, and chemical dichotomies are common motivations of the bifurcation cascade in angiosperms.

In angiosperm lineages molecular gradients are caused by sequential increase in oxidation level of compounds belonging to the different metabolic categories, and to stepwise abandonment of the intermediates of the shikimate pathway, followed by their replacement by mevalonate, acetate and citrate routes for the generation of the metabolic categories [(Gottlieb, Phytochemistry, 28 2545 (1989); 29 1715 (1990)] Superposition of these trends characterizes both, the iridoid and the polyacetylene lineages of Asteridae. Gradual oxidation of mevalonate derived monoterpenes to iridoids and acetate derived polyketides to polyacetylenes are both conditioned by the evolutionary demise of polyphenols This situation prevails during the initial stages of the evolution of Rosidae and it is at this point that the alternate lineages of Asteridae must be rooted In the most highly advanced members of these lineages the oxidation potential should increase the turnover rate of metabolites Hence they may easily escape detection, unless reactive functional groups, e g the formyl group in secologanin of Gentianales, are stabilized, as by reaction with tryptophane This compound appears as an overflow metabolite of the shikimate pathway to lignins in plants for which a strong trend towards herbaceousness can be demonstrated The resulting indolo-iridoid alkaloids are indeed accumulated only in Rubiaceae, Apocynaceae and Loganiaceae The more herbaceous members of these families and the closely allied herbaceous families of the Gentianales do not produce such alkaloids.

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CHE 5

Iridoids, systematic markers?

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Carbocyclic iridoids are monoterpenes with a cyclopentanopyran skeleton. Oxidative cleavage at the 7,8-bond of the cyclopentane moiety affords so called secoiridoids. Dahlgren [*Bot. Notiser*, 128: 119 (1975)] considered the iridoid producing angiosperms to belong to closely related superorders, employing substantially static presence absence criteria. The present effort concerns the systematic position of the iridoid containing taxa by dynamic criteria such as the biogenetic status of these metabolites as characterized by mean oxidation levels and skeletal specializations.

Actinidiaceae (Corniflorae *sensu* Dahlgren [*Bot. J. Linn. Soc.*, 80: 91 (1980)] were reported to contain by far the largest number of iridoid types. Nevertheless the representatives of all types show uniformly the lowest known oxidation levels (EAo -1.15) and skeletal specializations (EAs 0.28) for iridoids in any taxon. These parameters increase gradually from Corniflorae (resp. -0.27, 0.37) to Gentianiflorae (resp. -0.12, 0.45) and Lamiiflorae (resp. -0.10, 0.41) and are highest in Loasiflorae (resp. -0.05, 0.47). At lower hierarchic level resolution among such values is unsufficient to allow correlation of EAo and EAs values with morphosystematic data. Among the parameters selected for this purpose, percentual relationships between numbers of different compounds such as carbocyclic iridoids/secoiridoids (C/S), C_{10} iridoids/C_9 and C_8 noriridoids (C_{10}/C_9), Me-10 alpha/beta iridoids (α/β) as well as plant habit expressed by the mean herbaceousness index (HI) proved useful. The primordial C/S value is certainly 100/0 since it characterizes Actinidiaceae and in succession Fouquieriales, Ericales, Lamiales, Scrophulariales and Hippuridales, but not Loasales (93/7), Dipsacales (85/15), Cornales (68/32), Gentianales (67/33), Goodeniales (50/50), Oleales (18/82) and Sarraceniales (0/100). Again, the primordial C10/C9 value 100/0 characterizes Actinidiaceae and Fouquieriales, diminishing via Eucommiales (69/31), Ericales (60/40), Lamiales (47/53), Scrophulariales (34/66) towards Hippuridales (0/100). Loasales (8/92) also show this trend, again to be inverted in the sequence Cornales (76/24), Gentianales (88/12), Dipsacales (98/2), Goodeniales (100/0) and Oleales (100/0). Finally, the primordial α/β value should indeed be 100/0 as in Actinidiaceae, since a-methyl predominates in the series Eucommiales (100/0), Lamiales (87/13), Scrophulariales (83/17), Loasales (93/7) and Hippuridales (100/0). However Ericales (21/79) and Fouquieriales (0/100) may also prepare the transition towards the predominance of the β-directed Me-10 group as in Gentianales (43/57), Cornales (18/82), Dipsacales (2/98), Goodeniales (0/100) and Oleales (0/100). Segregating the clearly aberrant Fouquieriales and Loasales, gradients become neatly perceptible in both major evolutionary sequences, in confirmation of Dahlgren's proposal.

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CHE 6

Comparison pharmacognostic studies on some producents of alkaloids in Apocynaceae.

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The genus *Rauwoltia L. (Apocynaceae)* is of wide economic importance due to presence of indole alkaloids which have broad application in the treatment of circulatory diseases (reserpine, ajmaline, yohimbine and oth.).

We have analysed a number of plants from Vietnam's flora and some species introduced in Georgia. We were able to separate geographical races of *Rauwoltia vomitoria Afz.* and *R.serpentina Benth.* (from Vietnam) and *R.canescens L.* (from Cuba) with high alkaloid contents. Bark roots of these plants accumulate up to 6% total alkaloids and content of antiarritmic alkaloid ajmaline comes to 1.8% (*R.canescens, R.serpentina*) and 2,8% (*R.vomitoria*).

Now as a perspective raw material we offered *R.serpentina* tissue culture. A phytochemical characterization of *R.serpentina* tissue culture have demonstrated that this culture is the most efficient of the presently known systems. The results indicate that tissue produce mainly indolenines (especially vomilenine) and dihydroindoles (especially ajmaline). We have isolated and identified 7 different alkaloids from cultivated *Rauwolfia* cells. The tissue culture contained the high level of ajmaline (more than 2%). The major alkaloid of the plants reserpine was identified in trace amounts *R.serpentina* tissue culture. Tissue culture have been producing consistently high levels of alkaloids for more than 10 years. The alkaloid composition and concentration have not undergone more change during this period.

CHE 7

THE POSSIBILE PATHWAYS OF PRESERVE OF APOCYNACEAE WITH HIGH CONTENT OF ALCALOIDS

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The traditional methods of plant propagation in *Rauwolfia*, the important highalkaloid medicinal plant, are quite limited. The biotechnology offers not only the rapid and mass multiplication of existing stocks of germoplasm for quantative and qualitative analysis of secondary metabolites but also for the conservation of the important elite rare medicinal plants which are treated with extinction. Dure to rapid deforestation and depletion of genetic stocks concentrated efforts must be made to evolve methods for induction of genetic variability high yielding and resistance to pathogen.

A procedure for the regeneration of complete plantlets of *R..caffra* Sond. and *R..vomitoria* Afz. from cultured leaf callus via **organogenesis and embryoidogenesis is** suggested. In *R . caffra* the effect of different concentration of NNA (0.5-2 mg/l) in combination with BAP (0.5 2 mg/l) on MS basal medium were investigated to assess the induction of callus from leaf explants [Upadhyay, Makoveychuk, Nikolaeva, Batygina, *J. Plant Physiol.* 140: 218-222 (1992)]. The best response for callus induction and growth was obtained on medium containing 2mg/l NAA and 2 mg/l BAP. The callus was compact, whitish yelloy and fast growing. When subcultured, the fast growing callus promoted organogenesis on medium containing 0.5 mg/l BAP. However, if the calli were not subcultured regularly and allowed to age, embryoidogenic calli with globular embryoids were induced in the same organogenesis medium. When the developed embryoids were transfered to hormone-free MS medium , they developed into plantlets. The regenerants of *R..vomitoria* were received by the same modes but with the using of MS medium with 2.4 D (2-4 mg/l) and 2.4 D + BAP (2+2 mg/l). The embryoid formation occurs by departure of groups of cells accordingly to type of embryos with delayed histogen differentiation. In *R..vomitoria* in the cases of continious cultivation on the same medium without passages the nondirect (via callus) secondary embryoidogenesis was observed. In contrast to primary embryoids the secondary ones form from the single cells of callusing surface of primary embroids.

The proposed procedure can be used for the working out of the methods of conservation and repatriation of *Rauwolfia* plants in natural conditions.

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CHE 8

A contribution to the ethnobotany of Rubiaceae from India

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Ethnobotanical survey of the Central Himalayan Region of India as recognized by Vidyarthi & Rai (The Tribal Culture of India, New Delhi, 1985) was carried out. The major tribes found in the area are 10. These are; Tharus, Mushar, Gond, Nat, Oraon, Buksa, Jounsaris, Bhotia, Gujjar, and Raji.

The survey showed that a number of Rubiaceous taxa (23 species) have great medicinal value. They are also important as food, fodder and fibre plants. These are: *Adina cordifolia, Anthocephalus cadamba, Borreria articularis, Dentella repens, Gardenia gummifera, G. latifolia, G. jasminoides, Hamelia patens, Hamiltonia suaveolens, Hedyotis biflora, H. corymbosa, Hymenodictyon exelsum, Ixora arborea, Mitragyna parvifolia, Morinda coreia, Mussaenda frondosa, Paederia foetida, Pavetta indica, Rubia cordifolia, Wendlandia tinctoria, W. heynei, Xeromphis spinosa, and X. uliginosa.*

The method of administeration of the drugs obtained from these plants in the form of powder, decoction, infusion or expressed juice is of much significance as it, most probably, enhances the efficacy of these drugs. Certain plants claimed by tribals to be effective as abortifacient, (*Xeromphis spinosa*), in curing diabetes (*Rubia cordifolia*) and jaundice (*Hedyotis corymbosa, Mussaenda frondosa*) need thorough investigation. Critical scientific evaluation of these can provide newer resources to fight diseases.

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CHE 9

Medicinal plants of the family Rubiaceae in Vietnam and their use in the traditional medicine

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The Rubiaceae family with 80 genera and over 400 species is one of seven largest and most diversified families of the Vietnamese flora. In this family, about 53 species are used for treating diseases. Of them, 22 species are recorded in the book by Đỗ Tất Lợi "Medicinal plants and ingredients of Vietnam", 6th Ed., 1991. It belongs to the 27 following genera: Adina (1 species), Anthocephalus (1), Canthium (1), Chassalia (1), Cinchona (2, imported plant), Gardenia (2), Greenea (1), Guettarda (1), Hedyotis (3), Hydnophytum (1), Hymenodictyon (1), Ixora (5), Lasianthus (1), Morinda (4), Mussaenda (5), Myrmecodia (1), Nauclea (2), Neonauclea (1), Paederia (2), Pavetta (1), Prismatomeris (1), Psychotria (4), Randia (5), Rubia (1), Serissa (1), Tarenna (1), Uncaria (3).

There is some notes on the feature of traditional medicine:

- One plant / drug can be used for treatment of different diseases.
The mode of plant / drug use and the prescription for treating disease varies from one healer to another. It is used either singly or in combination.
- Numerous drugs are used after processing with the traditional method.

On the basis of traditional knowledge, a new drug can be selected and developed.

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PAL 1

The "*arabica-congensis* complex": five *Coffea* species with a problematic delimitation

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The genus *Coffea* consists of 53 accepted species, of which only those of East Africa were revised recently [Bridson, *Flora of Tropical East Africa. Rubiaceae (part 2):* 703-723 (1988)]. At present, we study the Central and West African species. In this investigation it became clear that five species, viz. *C. arabica, C. congensis, C. eugenioides, C. kivuensis* and *C. stenophylla,* form a problematic "*arabica-congensis* complex" wherein borderlines between species are difficult to trace, because there seems to be considerable morphological overlap between each of them. In the past those five species have been accepted [Lebrun, *Institut Royal Colonial Belge, Section Sciences Naturelles & Médicales* 11(3) (1941)], although the status of *C. kivuensis* has been questioned [Chevalier, *Encyclopédie Biologique* 18: 218 (1947)].

In order to evaluate the morphological and anatomical variation and in view of a numerical analysis of the variation of these characters, all available useful herbarium specimens were analysed in detail. As specimens are seldomly provided with flower and fruit, the data set was split into two separate matrices pertaining to flower and fruit characters respectively, each combined with vegetative characters. Cluster analyses were performed using SYSTAT [Wilkinson, *Systat. The system for statistics, Evanston, Illinois: Systat, Inc.* (1988)].

The analysis of the matrix for floral and vegetative characters (109 specimens, 91 states in 35 characters) yielded no useful clustering. The matrix for fruit and vegetative characters (76 specimens, 101 states in 37 characters) on the contrary resulted in a clustering largely consistent with existing species concepts [Lebrun, *ibid.* (1941)] and with cytological, ecological and distributional data.

Within the '*arabica-congensis* complex' we propose to maintain the species delimitation as used by Lebrun, although further studies are needed, especially by using evidence from other fields than morphology and anatomy.

PAL 2

Chromosomes of Pacific Rubiaceae

Michael KIEHN, Institute of Botany and Botanical Garden, University of Vienna, Austria

Chromosome numbers and/or ploidy levels can provide important information about the phylogeny, the evolution, and the relationships between plant groups. This especially holds true for angiosperms in coastal areas and in oceanic islands, where due to long distance dispersal and isolation (more or less intensive) speciation and radiation often starts from a single introduction.

69 genera of Rubiaceae are reported for the Pacific [Van Balgooy, Pacific Plant Areas 5: 233-234 (1993)]. They comprise widespread pantropical genera with numerous species (like *Psychotria* or *Spermacoce*), Pacific endemic genera (such as *Calycosia* or *Cyclophyllum*) and island endemics with few to only one species (like the Hawaiian *Bobea* or the Fijian *Gillespiea*, *Hedstroemia*, *Readea*, *Squamellaria*, or *Sukunia*).

The poster presents a survey of the actual karyological knowledge about rubiaceous taxa occuring in the Pacific: for ca. 30 genera and ca. 120 taxa there is at least one count on a Pacific origin. However, 55 of these 120 taxa belong to the genus *Coprosma*, only few of them occuring outside New Zealand. Thus for most other genera only one or two Pacific species have been investigated chromosomally so far. Besides this considerable lack of information there is also a gap regarding the geographical distribution of the available data: none or less than 5 counts on Rubiaceae exist from large Pacific Islands such as the Philippines, Borneo, Sumatra, Java, New Caledonia, Fiji, or Samoa.

Based on the available chromosomal data the poster shows implications for a discussion of relationships, speciation, radiation, and evolution in selected groups of Pacific Rubiaceae (e.g. Psychotrieae, Guettardeae).

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PAL 3

Ancylanthos reconsidered

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While constructing the key to the Vanguerieae for the Flora Zambesiaca it became apparent that the current circumscription of *Ancylanthos* should be questioned. Traditionally *Ancylanthos* was characterised by its long often curved corollas and leaves with a dense indumentum beneath. However, this apart, the five species have little in common.

Images of the species currently placed in *Ancylanthos* are shown together with a table listing their most useful diagnostic characters. Four species can be more closely associated with other genera (or currently accepted genera):- *A. lactiflorus* Welw. ex Hiern with *Fadogia*; *A. monteiroi* Oliv. with *Lagynias* (if truly distinct from *Pachystigma*); *A. rhodesiacus* Tennant with *Tapiphyllum* and *A. rogersii* Wernh. with *Fadogiella*. The type species, *A. rubiginosus* Desf., alone remains and *Ancylanthos* becomes a monotypic genus.

PAL 4

The generic status of *Oxyanthus gossweileri* (Rubiaceae) from Angola

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Oxyanthus gossweileri from Angola has been described from a single specimen collected in 1906. A search in herbaria holding Angolan collections has revealed an additional flowering specimen allowing a sound morphological and pollen morphological investigation. It is concluded that '*O. gossweileri*' must be kept in the Gardenieae-Gardeniinae but deserves generic segregation. The new genus *Ganguelia* is a pyrrhophytic geofrutex with densely hairy, suborbicular leaf blades with subpalmate venation. Chorologically, *Ganguelia* is endemic of the western part of the Zambezian Region; in the Rubiaceae, the monospecific *Calanda* (Knoxieae) has a very similar narrow distribution.

Ganguelia seems to exhibit two pollen morphological features which are unique among the Gardenieae genera with tetrad pollen. The calymmate condition of the tetrads is atypical. Colporidorate grains occur together with the pororate ones characteristic for Gardenieae tetrads. The decussate arrangment of a part of the tetrads, not yet reported from the Rubiaceae, was previously overlooked in several genera and is hence not a peculiarity of the new genus.

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PAL 5

The status and evolution of *Trichostachys* (Psychotrieae)

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The monophyly of *Trichostachys* (*Psychotrieae*) is tested using 28 morphological and seed characters within a phylogenetic framework. Monophyly of *Trichostachys* is supported, although the resulting phylogeny suggests that *Psychotria* s.l. is paraphyletic. Examination of the morphological characters traditionally used to delimit species within *Trichostachys* reveals that most characters exhibit clinal variation or are homoplasious. These results suggest accepting three broad *Trichostachys* species, separated according to inflorescence structure.

PAL 6

Studies on the tribal status of certain Indian genera

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Detailed morphological investigations of vegetative structures and features of fertile regions along with ultramicroscopic studies of pollen and seed coat were carried out. An evaluation of data obtained has led the author to propose a new tribe to accomodate *Clarkella* and arrive at generic closeness, taxonomic affinity and appropriate status for *Polyura*, *Myrioneuron*, *Neohymenopogon* and *Dunnia*.

1. *Clarkella* is saxicolous, stem quadrangular, winged at angles; leaves decurrent, capsule obconic, semicoriaceous, late dehiscent through pores; pair of cotyledons adherent above, hypocotyl enlarged to form a tuber engulfing the remaining parts of embryo; tuber undergoing morphological and anatomical changes forming a fleshy structure excavated inside, with nodes, internodes and numerous adventitious roots etc. a scaly sheath appearing at the apical part through which the seedling grows. For these distinguishing characters *Clarkella* is treated as a unigeneric tribe *Clarkelleae* Deb, tribus nov.

2. *Polyura* is very close to *Spiradiclis* in habit, leaves, stipules, inflorescence, minute monomorphic flowers, persistent calyx, corolla form, insertion of stamens, bilocular ovary with numerous ovules, minute embryo and fleshy endosperm. With recognition of the tribe *Ophiorrhizeae* that includes *Spiradiclis*, *Polyura* is included in this tribe.

3. *Myrioneuron*. Branches with conspicuous spongy corky bark; leaves, stipules, bracts, calyx lobes etc. without marginal stalked glands; stipules bifid, flowers bisexual, monomorphic, berry with horny cocci etc. distinguish this genus from *Keenania* and *Mycetia* and can not be treated as synonymous with any of these.

4. *Neohymenopogon* and 5. *Dunnia*: Specimens of *Neohymenopogon* and *Dunnia assamica* were studied in detail. Mature seeds of the latter were studied for the first time. 42 character states were compared. 15 of them are common to *Hedyotideae* and *Cinchoneae*. Presence of raphides in the tissues, peltate placenta borne on a stalk at the base of the ovary locule and parenchymatous exotesta are characteristics of *Hedyotideae* but are absent from *Cinchoneae*. Seeds are slightly winged in *Neohymenopogon*, but club shaped excrescences of exotesta are present in *Dunnia assamica*. Thus the evaluation of character states confirm their inclusion in the *Hedyotideae*.

PAL 7

Sectional characteristics of Indian *Hedyotis* s.l.

Ratna DUTTA, Botanical Survey of India, Calcutta, India

Wight & Arnott (1834) united the genera *Hedyotis*, *Oldenlandia*, *Kohautia* and *Anotis* under the genus *Hedyotis* but subdivided it into 5 sections. Hook.f. (1880) treated *Hedyotis* into 5 sections and *Oldenlandia* into 3 subgenera. Schumann (1891) united *Hedyotis* and *Oldenlandia* into one genus naming it *Oldenlandia* and treated in 12 sections following Hook.f. (1973, 1880). Bremekamp (1952) raised the section to the status of genus, being followed by Hepper (1961) and Verdcourt (1976).

In the present study Indian species of these genera are treated under 7 sections of the genus *Hedyotis*, on the basis of macroscopic character of vegetative and floral parts along with microscopic and ultramicroscopic study of pollen and seed coat. The sections are characterised as follows.

1. Section *Hedyotis*: mainly by axillary inflorescence, capsule, crustaceous, hard, indehiscent or late dehiscent.
2. Section *Kohautia*: monomorphic flowers with slender corolla tube swollen above with included stamen on the swollen part of the corolla tube, capsule dehiscing loculicidally.
3. Section *Oldenlandia*: short or long corolla tube, included or exserted stamens, iso- or heterostylous flower, capsule dehiscing loculicidally.
4. Section *Scleromitrion*: leaves one nerved, axillary inflorescence, isostylous flowers, capsule dehiscing on the crown only, calyx teeth converging in fruit.
5. Section *Involucrella*: leaves one nerved, terminal capitate cyme hidden in the involucrate leaf bases and stipules, capsule obscurely dehiscent, calyx teeth converging.
6. Section *Diplophragma*: shrubby habit, deciduous stipules leaving scar, capsule septicidally dehiscent.
7. Section *Anotidopsis*: terminal capitate or subcapitate cyme, capsule keeled or narrowly winged, compressed, membranous, loculicidally dehiscent.

This poster will present the delimitations of different section in a tabular form.

PAL 8

Distribution pattern of rare and endangered *Rubiaceae* in Arunachal Pradesh, India

B.C. Sabata, Jawaharlal Nehru College, India

Arunachal Pradesh in India occupies an unique role in plant diversity and situated in the North-East. It boundaries China, Mayamar and Himalayas. Phytogeographically it is important to note that many South African and Malesian flora still exist in this area. In the present global situation, this region recognised as one of the hot-spots for biodiversity conservation. Rubiale members like *Hedyotis scabra* Wall. ex Kurz, *Leptodermis scabrida* Hook.f., *Nertera smensis* Hemsley and *Psychotria aborensis* Dunn which are in the list of Red data book of BSI (Botanical Survey of India) are present in the region. Present investigation deals with the status, distribution pattern and taxonomic description of the plants.

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PAL 9

A taxonomic study on the genus *Lasianthus* in East Asia

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A taxonomic study on the genus *Lasianthus* Jack from east Asia (China and Japan) has been done. Thirty -three species including six subspecies and eight varieties from China and Japan are recognised, of which, four new combinations [*L. oblongifolius* Bedd. subsp. *trichophlebus* (Hemsl.) H.Zhu, *L. biermannii* King ex Hook.f. subsp. *esquirolii* (Level.) H.Zhu, *L. verticillatus* (Lour.) Merr. var. *truncatus* (Bedd.)H.Zhu and *Lasianthus lucidus* Bl. var. *inconspicuus*(Hook.f.) H.Zhu] , one new state [*L. rhinocerotis* Bl. subsp. *pedunculata* (Pitard)H.Zhu] are established; two species [*L. tomentosus* Bl. and *L. wardii* Fischer] are recorded as new to China , and also four species names, one subspecies name and four variety names are reduced as new synonyms[*L. tubiferus* Hook.f.=*L. inodorus* Bl., *L. poilanei* Pitard=*L. inodonus* Bl, *L. bunzanensis* Simizu=*L. brevidens* Craib, *L. hoaensis* Pierre ex Pitard =*L. kurzii* Hook.f.; *L.biermannii* King ex Hook.f. subsp. *crassipedunculatus* C.Y.Wu et H.Zhu= *L. biermannii* King ex Hook.f. subsp. *esquirolii* (level.)H.Zhu; *L. longisepalus* Gedd. var. *jianfengensis* H.S.Lo =*L.longisepalus* Gedd., *L. kurzii* Hook.f. var. *howii* H.S.Lo =*L. kurzii* Hook.f. var. *kurzii*, L. verticillatus (Lour.)Merr. var. taitoensis(Simizhu) H.Zhu =L. verticillatus (Lour.) Merr. var. truncatus (Bedd.)H.Zhu , *Lasianthus lucidus* Bl. *caudisepalus* Deb. et Gang. = *L. japonicus* Miq.]. Some mistakes and confusion in the genus mainly in Chinese botanical references are clarified.

Geographic significance of some species are also discussed. It is complicated that the flora of Himalayas have close affinity to the flora of eastern Asia in origin and the ended parts of Himalayan-Hengdwan Mts., i.e. Tenasserim and Arakan Mts. seems to act as a migration track connecting Himalayan flora and the mountain flora of Malaysia and Indonesia.

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NEO 1

Overview of the Psychotrieae (Rubiaceae) in the Neotropics

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The pantropical tribe Psychotrieae is represented by two pantropical and nine exclusively neotropical genera in the Neotropics. *Psychotria* L. (ca. 600 neotropical species) as commonly circumscribed appears to comprise two or three groups that are probably better treated separately: Subgenus *Psychotria* (– *Mapouria* Aubl.), which is pantropical; Subgenus *Heteropsychotria* Steyerm. (including *Cephaëlis* Sw., *Nonatelia* Aubl., and *Ronabea* Aubl.), which is completely neotropical; and the succulent herbaceous plants segregated in Subg. *Heteropsychotria* Sect. *Notopleura* Benth. (including *Montamans* Dwyer), all neotropical, which may be better treated as a separate genus. The neotropical genera *Rudgea* Salisb. (ca. 170 species) and *Palicourea* Aubl. (ca. 200 species) appear to be closely related to Subgenus *Heteropsychotria*. *Palicourea* at least is probably derived from within this subgenus. However, because of the large numbers of species and names in this group, no nomenclatural changes are proposed at this time.

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NEO 2

Taxonomy of the neotropical genus *Coutarea* (Rubiaceae)

Helga OCHOTERENA-BOOTH, L.H. Bailey Hortorum, Cornell University, NY U.S.A.

The complex taxonomic history of the genus *Coutarea* includes problems of delimitation both for the genus and the species. In addition, tribal affiliation and recognition of infraspecific taxa (i.e., varieties and forms) are controversial. This medicinally important genus (*e.g.*, antibiotic and anti-inflammatory activity) is found in the Neotropics, from Southeastern Mexico, throughout Central America, extending to Northern Argentina and Southern Brazil. The greatest diversity of species, morphological variation within species, habit (i.e. trees, shrubs, vines), occurs in South America. Morphological studies of 1,600 specimens of *Coutarea* and related genera (particularly *Hintonia* and *Coutaportla*) led to the conclusion that *Coutarea* should be recognized as a distinct taxon from *Hintonia*. *Coutarea* is characterized by curved stamens (an autapomorphy) and the unique combination of the following characters: fruits flattened perpendicularly to the septum, vertical placentation and winged imbricated seeds. In contrast, *Hintonia* has straight stamens, and the singular combination of unflattened fruits, horizontal placentation, and winged seeds. A preliminary cladistic analysis that included *Coutarea* and 12 related genera (plus the outgroup) suggests that winged seeds are homoplastic in *Hintonia* and *Coutarea* and that *Coutarea* is more closely related to *Coutaportla*. Although morphological variation within species, either in vegetative or in reproductive features, makes specific delimitation difficult, 3 species are recognized. *Coutarea andrei* is the most easily identified with its red actinomorphic pentamerous corolla. The other two species (*C. alba* and *C. hexandra*) are difficult to distinguish when only flowers are present but show differences in the fruit and leaves. A possible new species may be present in Bolivia but only one specimen without fruits has been examined. Infraspecific taxa are not accepted and a new combination is made for *Coutarea lindeniana*.

NEO 3

Biogeography and ecological specializations in the neotropical genus *Exostema* (Rubiaceae) from a phylogenetic perspective

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Exostema is a genus of trees and shrubs concentrated in the Greater Antilles, with three endemic species in South and Central America. The genus is of interest for its extreme morphological diversity, its anti-malarial value, and for its uncertain tribal affiliations. Taxonomic revision of *Exostema* , based on herbarium and field studies, morphology, leaf and pollen anatomy, cytology and DNA sequences has resulted in recognition of 25 species (vs. previous total of 47 spp), 19 of which are endemic to Cuba and Hispaniola. Spinulose pollen and chromosome counts (n=13) help to define the genus, and support exclusion of the Mexican species *E. colteri*, which is referred to *Syringantha* (Standl.). A phylogenetic analysis using 40 morphological and anatomical characters was performed to assess relationships within *Exostema*. Three monophyletic groups were resolved, which are recognized as sections in the present revision. The sections are distinguished by inflorescence position and flower size, with various supporting characters including pollen and stomata size. A survey of ITS rDNA sequences for nine *Exostema* species and outgroups strongly supports this infrageneric classification. Within the terminal inflorescenced long flowered group *E.* sect. *Pitonia*, two subsections are distinguished on the basis of habit, vestiture, and fruit characters. Among the five shrubs species in *E.* subsect. *Longiflora* are four theophytic species, which the previous classification [Borhidi & Fernandez, Act Bot. Hung. 35: 287 (1989)] had separated into three sections. Despite their extreme divergence in leaf, flower, fruit and seed characters, examination of these and other features indicates that *E.* sect. *Longiflora* is a natural group which is correctly placed within *E.* sect. *Pitonia*.

Each section of *Exostema* includes numerous Antillean species and 1 or 2 mainland species. Species proliferation in the West Indies, greatest in the islands of Cuba and Hispaniola, appears to have resulted from the fragmentation and reconnection of land masses during the geological evolution of the Caribbean region, and from the derivation of xeric (drought adapted) traits in each major lineage of the genus. Species endemic to serpentine substrates and/or riparian habitats also occur in each of these lineages. A biogeographical hypothesis of multiple migrations from South America to the Greater Antilles via Central America was tested, and the results are compared to theories of Caribbean geological history and patterns of Neotropical biogeography.

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NEO 4

The generic delimitation of *Oreopolus* and *Cruckshanksia* (Hedyotideae)

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The relationships of *Oreopolus* Schlecht. and *Cruckshanksia* Hooker & Arnott are reconsidered based on cladistic analysis of morphological characters. These genera share a similar unusual gynoecium. Based on cladistic analysis of morphological characters, *Oreopolus* is here distinguished by its ternate leaves and circumscribed to include one species, and *Cruckshanksia* is here circumscribed to include seven species united by 3-7-lobed foliaceous floral bracts and calyx lobes that expand markedly into pterophylls in fruit, and are often also expanded into semaphylls in flower.

NEO 5

Rosenbergiodendron (Rubiaceae, Gardenieae) resurrected

Claes GUSTAFSSON, University of Göteborg, Sweden

Fagerlind [Arkiv f. Botanik 30(3): A no. 7 (1943)] on the basis of shoot growth patterns, split the very heterogenous genus *Randia* into several more distinct groups and restricted *Randia* to become a strictly American genus. Already in 1943 Fagerlind pointed out that the homogenous "*Randia formosa* group", also strictly American, should not be kept within *Randia*, but should be treated as a separate genus. Eventually Fagerlind [Svensk Bot. Tidskr. 42: 143–152 (1948)] published the new genus *Rosenbergiodendron* to accomodate the "*Randia formosa* group". He was not followed by other authors however, and his publications seem to have been generally disregarded. Neither Steyermark [Mem. N. Y. Bot. Gard. 23(9): 325–329 (1972)] nor Dwyer [Ann. Miss. Bot. Gard. 67(2): 442–447 (1980)] recognized the genus. In the latest overview of tropical *Rubiaceae* [Robbrecht, Opera Bot. Belg. 1 (1988)] *Rosenbergiodendron* is synonymized under *Randia*.

Rosenbergiodendron comprises two species, which range from Panama to Peru, and is separated from *Randia* by the following characters: Pollen in monads, 4–7 zono-aperturate or 5–13 panto-aperturate, plants unarmed, flowers hermaphrodite, immature fruits green with broad white stripes down their sides, and corolla tubes conspicuously elongated.

NEO 6

Infrageneric classification of *Borreria* (Rubiaceae-Spermacoceae) on the bases of American species

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The genus *Borreria* is, according to its number of species, the most important of the tribe Spermacoceae. Although it grows in tropical areas, its main concentration is in the South America. It is defined by isomorphic flowers, capsular fruits, indehiscent mericarps and axillar and/or terminal glomerate inflorescences. In this work, near 100 of South American species are studied and an infrageneric classification based on morphological characters is proposed, these are: dehiscence of the fruit, length and position of stamens, length of style, shape of stigma and seed surface.

The genus can be divided into two subgenera according to the mericarp dehiscence:
subgen. *Borreria* with capsular fruits, and
subgen. *Dasycephala* Cabral & Bacigalupo with mericarps in any case indehiscent.

The second subgenus is represented by species separated from the genus *Diodia* s.l., since *Diodia* s.str. is defined by fruits completely indehiscent and 1-3-axillary flowers, partially hidden by the foliar sheats. *Hemidiodia ocimifolia* (Willd.) Schum. characterized by fruits with two mericarps, the one totally indehiscent and the other partially opening at the base, is also included in this subgenus.

NEO 7

PROPOSAL FOR AN INFRAGENERIC DIVISION IN *TOCOYENA* AUBL. (RUBIACEAE)

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A taxonomic revision of the neotropical genus *Tocoyena* Aubl. (*Gardenieae-Gardeniinae*) was made. The identification of the species and the interrelationships amongst them were based on morphological features. Of the twenty-four species reported in the literature, 15 were considered as valid for Central and South America. Floral aspects were very useful for the infrageneric classification.

Two sections were proposed, based on the shape of the corolla lobes and of the flower bud tips: Sect. *Tocoyena* (flower bud tip obtuse or short acuminate) and Sect. *Acutiflorae* (Schum.) Prado & Kinoshita *Sect. et Stat. nov.* (flower bud tip acute). These Sections were based on Schumann's Series [*Rubiaceae. In: Die Naturlichen Pflanzenfamilien. V. 4.* p. 74 (1891)] for the seven known species. From 1891 on, eight new species were described by different authors and were included here. All species were considered in relation to these morphological features, with exception of *T. amazonica*, based on a non-flowering collection.

Tocoyena Aubl. Sect. *Tocoyena* includes: *T. bullata* (Vell.) Mart., *T. formosa* (Cham. & Schlecht.) Schum., *T. longiflora* Aubl., *T. pendulina* Spr., *T. pittieri* (Standley) Standl., *T. sellowiana* (Cham. & Schlecht.) Schum., *T. tabascensis* Standl., and *T. viscidula* Mart. Most of the species occur in extra-Amazonian forests.

Tocoyena Sect. *Acutiflorae* (Schum.) Prado & Kinoshita is composed of *T. cubensis* Britton, *T. foetida* Pöepp. & Endl., *T. guianensis* Schum., *T. hispidula* Standl., *T. neglecta* N. E. Brown, *T. surinamensis* Standl. & Steyerm., and *T. speciosa* (Krause) Prado & Kinoshita. Most of the species occur mainly in the Amazonian forest.

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NEO 8

PATTERNS OF DISTRIBUTION IN *TOCOYENA* AUBL. (RUBIACEAE)

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An analysis of the geographical distribution of the 15 species of *Tocoyena* Aubl was carried out, based on the infrageneric division proposed by Prado & Kinoshita (inedit). The maps were elaborated plotting the localities mentioned in the exsiccatae.

Tocoyena occurs mainly in the Neotropical region, its representantives growing in different types of vegetation including forests, savanas ("cerrados"), "caatinga", "restinga" and open vegetation. Nearly fifty percent of the species are found in forests.

Most of the species of the Section *Tocoyena* are from extra-Amazonian forests (*T. bullata, T. longiflora, T. pendulina, T. pittieri and T. sellowiana*). Other species occur in savanas ("cerrados"), two of them in South America (*T. formosa* subsp. *formosa* and *T. viscidula*),and one is restricted to the South of Mexico (*T. tabascensis*). *T. formosa* subsp *tomentosa* is found in "caatinga" in the Northeast of Brazil.

In the Section *Acutiflorae* (Schum) Prado & Kinoshita, most of the species tend to be found in the Amazonian forest (*T. foetida, T. guianensis, T. speciosa* and *T. cubensis*) Two other species occur in transitional vegetation between open vegetation and Amazonian forest (*T. hispidula* and *T. orinocensis*) and one is restricted to the "cerrado" in the extreme North of Brazil (*T. neglecta*).

T. formosa subsp. *formosa* has the widest distribution, occupying a great extension in the "cerrado"of South America. On the other hand, *T. guianensis* is largely found in the Amazonian forest. Both species present a considerable range of polymorphism.

NEO 9

Manettia Mutis in the Itatiaia National Park Rio de Janeiro, Brazil

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The Itatiaia National Park is situated in the Northwest of Rio de Janeiro state end Southwest of Minas Gerais state (22° 19' - 22° 45'S : 44° 45' - 44° 50'W), with an area ca. 30,000 ha. It belongs to the Mantiqueira range reaching a maximum altitude of 2787m, with rocky cliffs and huge bouders. Uplift of the area probably dates from the Late Cretaceous.

The vegetation is divided according to the altitude, with tropical rain forest at low altitude near the Paraiba river and Araucaria forest in the valleys. At higher levels there is a montane forest between 1800 - 2000m, open vegetation and scrub on the plateau.

Saint Hilaire, Sellow, Wawra, Glaziou and Ule, in the past century, and P.Dusén at the begining of the present one, collected plants and studied the vegetation of Itatiaia.

Manettia Mutis is a Neotropical genus with ca. 120 species, with 40% of them occurring in Brazil. Most of the species are concentrated in the Rio de Janeiro state. In the Itatiaia National Park, 8 species of *Manettia* were found. Two species are endemic, and occurring up to 2000m, one of them is a new species. Descriptions, phenological data and illustrations of the species with an analytical key are presented here.

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NEO 10

The genus *Guettarda* in northeast Brasil

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Guettarda L. is mainly a tropical American genus of about 80 species of trees and shrubs [Dwyer, *Ann. Missouri Bot. Gard.* **67**: 198 (1980). The genus can be distinguished from other Rubiaceae genera by its characteristically dichotomous inflorescence, truncate calyx, undivided style and globose or oblong drupaceous fruits. It is present in the different types of vegetation that occur in northeast Brazil, especially in the caatinga.

In his treatment of Rubiaceae for Brazil, Müller Argovensis [*Flora Bras.* **6**(5): 14-27 (1881)] described 15 species of *Guettarda*; 9 occurred in the northeast. Later on, 3 more species were described on specimens collected in northeast Brazil.

This study was based on the detailed analysis of type material and other historical collections of the genus deposited at Kew (K), the survey of the genus in several herbaria in Brazil (R, RB, SP, EAC, TEPB, JPB, EAN, IPA, UFP, PEUFR, ASE, ALCB, HUFES, HRB), and the consultation of original descriptions and specialized bibliography for the species.

Expanded descriptions, comments on geographic range, synonymy and a key to species are presented. A new species, *G. grazielae* M.R. Barbosa, found in atlantic forest remanents in Paraiba state, is described and illustrated. *G. platypoda* DC. is the species with the widest distribution; *G. angelica* Mart. ex M. Arg. and *G. sericea* M. Arg. are restricted to the caatinga's dominium.

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NEO 11

Genipa infundibuliformis (sp. ined.), a remarkable Brazilian species overlooked since 1889

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A new and interesting species of *Genipa* L., *G. infundibuliformis* Zappi & Semir is described from Southeastern Brazil, and differs from the widespread neotropical *G. americana* L. by its infundibular flowers, toothed calyx-lobes and chromosome number. The new taxon is known mostly from cultivated plants in the states of São Paulo, Rio de Janeiro and Minas Gerais. One of the most interesting characteristics of *Genipa infundibuliformis* is the presence of lobed juvenile leaves both on young plants and basal sucker shoots, where these remain in the shade.

The existence of more than one species was first suspected by Guerra [*Citologia* 58: 427-432 (1993)], while discussing pre-existing chromosome counts of *Genipa americana* L. (2n = 22) and (2n = 20). He attributed the latter count to a possible misdetermination of the source material. This fact prompted examination of herbarium material from native stands and from cultivated sources available near Campinas (São Paulo state, Brazil): it became obvious that there were two morphologically distinct taxa known as *Genipa americana* L. and that there was confusion about the precise application of this name.

It is not easy, however, to attribute names to these taxa. Linnaeus [*Systemae Naturae... editio decima*, 2 (1759)] based the name *Genipa americana* L. on two illustrations: Plumier [*Plantarum americanarum*, pl. 136 (1757)] and Marcgrave [*Historiae rerum naturalium Brasiliae*, p. 92 (1648)], both showing plants with short flower-tubes and truncate calyx. The main difficulty concerning the identity of *Genipa americana* L. perhaps originates from the illustration used by Schumann [(Flora Brasiliensis 6(6): pl. 143 (1889)]. The habit drawing clearly shows the flower of *Genipa infundibuliformis*, although the dissection of the flower at the bottom of the plate shows what could possibly be a flower of the true *G. americana*. Perhaps this mixed plate is the reason why this species has remained overlooked for more than one century, since the Flora Brasiliensis continues to be a major source of reference for Brazilian and foreign botanists alike. However, the concept of *Genipa americana* must be linked to the material in which the species was initially based, and on its lectotype, Marcgrave's (l.c., 1648) illustration.

The basic chromosome number in Rubiaceae is n = 11, but diploidy and polyploidy (2n = 6n) are fairly common within the tribe Gardenieae [Robbrecht, *Opera Botanica Belgica* 1: 116 (1988)], and *Genipa americana* falls within this pattern (2n = 22). *Genipa infundibuliformis*, however, has quite an unusual chromosome count, possibly derived from *Genipa americana* or its ancestor through aneuploidy.

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NEO 12

Flora of the Serra da Juréia, São Paulo, Brazil: Rubiaceae

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The Serra da Juréia lies within the boundaries of the Juréia-Itatins Ecological Station, between parallels 24°17'-24°40'S and 47°00'-47°30'W, in the southern part of São Paulo State, Brazil. The Station includes parts of the municipalities of Iguape, Peruíbe, Itariri and Miracatu; the region of the Serra da Juréia covers 3,300ha of well preserved primary Atlantic forest, to altitudes of about 400-600 meters.

In the area, the Rubiaceae are the second largest family in species diversity, and are represented by the following genera (number of species): *Alibertia* (1); *Alseis* (1); *Amaioua* (1); *Bathysa* (1); *Coccocypselum* (3); *Coutarea* (1); *Diodia* (2); *Emmeorhiza* (1); *Faramea* (2); *Geophila* (1); *Guettarda* (1); *Hillia* (2); *Ixora* (1); *Malanea* (1); *Posoqueria* (1); *Psychotria* (14); *Randia* (1); *Rudgea* (3); *Rustia* (1) and *Tocoyena* (1). Habits vary greatly, and includes herbs, shrubs, and small to tall trees (*Bathysa meridionalis*, *Tocoyena sellowiana*). The species are commonly found on slopes and lowland forests and in the "campos"; they are important components of the understorey layer.

The material studied was obtained during expeditions from 1990 to 1994. Field observations were made to establish the morphological variations within species, especially in populations of *Psychotria* and *Rudgea*. *R. jasminoides* displayed the greatest variability in leaf morphology.

Keys to genera and species, descriptions, illustrations, and comments on the phenology and geographical distribution of the species are presented in this paper (CAPES, MacArthur Foundation).

BIO 1

Inflorescence structure and diversification in Rubiaceae

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Inflorescences are not only structural patterns of ramification but as well functional patterns serving as 'flower presenters' during the process of pollination and as diaspore releasers after anthesis. In numerous taxa of the Angiosperms the inflorescence as a whole becomes a superior functional unit.

The Rubiaceae are a good example to demonstrate how the given terminal determined thyrse is transformed into a flowerlike inflorescence. Pincushionlike attraction units result from aggregation and disindividualization of the flowers, floral pseudocorollas result from the enlargement of singular calyx-lobes (at least in 18 genera and 8 tribes of the Rubiaceae) and extrafloral pseudocorollas result from the integration of petaloid leaves (at least in 7 genera and 5 tribes of the Rubiaceae).

Selected examples of modified inflorescences are shown in detail demonstrating the general trend to fix number and position of the showy elements and to transfer them to the periphery of the whole inflorescence. Some theoretical conclusions try to illuminate the ontogenetic and evolutionary conditions of inflorescence diversification in Rubiaceae.

BIO 2

Theligonum cynocrambe
The developmental morphology of a peculiar rubiaceous herb

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Theligonum cynocrambe is an annual prostrate herb from the Mediterranean region. It shows a peculiar combination of characters: switch from decussate to alternate phyllotaxis (with 90-100° divergence), stipulate leaves, colleters, monoecy, anemophily, strongly reduced flowers lacking a calyx, a dimerous to trimerous fused corolla in both male and female flowers, male flowers (with 2-11 or up to 30 stamens) opposite to the leaf, female flowers in small dichasia in the leaf axils, with inferior uniovulate ovary and basilateral style and perianth, drupaceous fruits.

We provide additional developmental and morphological evidence in favour of the view that *Theligonum* belongs to the Rubiaceae [Wunderlich, *Osterr. Bot. Z.* 119: 329-394 (1971), Robbrecht, *Opera Bot. Belg.* 1: 1-271 (1988), 6: 19-30 (1993)]. The male flowers have 2-3 fused petals arising as continuous lobes on the periphery of the floral primordium. In flowers with two petals the androecium emerges as an elliptical rim (common girdling primordium) with a central depression. This rim is then divided up into several stamen primordia nearly simultaneously. In some cases two horseshoe-shaped primordia alternating with the petals were seen. Growth of the median stamens (in front of the petals) may be accelerated as compared to the lateral ones. In male flowers with three perianth lobes and a reduced stamen number the stamen primordia seem to occupy first the corners alternating with the perianth lobes, as typical for other Rubiaceae [see also Caruel, *Nuov. Giorn. Bot. Ital.* 5: 165-171 (1873)]. Thus there are no epipetalous androecial primordia as suggested by Balicka-Iwanowska [*Flora* 83: 357-366 (1897)] and Schneider [*Flora* 106: 1-50 (1914)]. Male flowers occasionally show a hemispherical base that may be interpreted as remnant of the inferior ovary, similar to the male flowers of *Nenax arenicola* as described by Puff [Fig. 33e, g, *Plant Syst. Evol., suppl.* 3: 1-535 (1986)]. Thus, the pseudanthium hypothesis has to be refuted. In the female flower a ring primordium grows into a tube with 2 (rarely 3-4) petal lobes. The tube becomes displaced adaxially by uneven growth. The lower ovary regio is provided with a septum that is overtopped and obscured by the single curved ovule. The *Theligonum* ovary is basically bilocular as typical for most Rubiaceae.

It is concluded that *Theligonum* clearly belongs to the Rubiaceae [see Wunderlich, *ibid.* (1971), Robbrecht, *ibid.* (1988) tribe *Theligoneae*] although a deepened study is needed to decide about its relationship to other tribes such as *Anthospermeae* (*Nenax*, *Putoria*) and *Rubieae* (*Didymaea*).

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BIO 3

A survey of secondary pollen presentation in the Rubiaceae

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Following the most recent classification system of the Rubiaceae, up to date information on the occurrence of **secondary pollen presentation (SPP)** is given on a tribe to tribe basis. The contribution includes a literature review, supplemented by original observations and investigations. Various previously published erroneous reports are corrected; hitherto unknown occurrences of SPP are added.

General aspects of SPP (with special reference to the Rubiaceae) are discussed:

- correlation between pollen presenter type, bud shape, anther size and position;
- surface adaptations of the pollen presenters;
- SPP and pollination syndromes;
- SPP and prevention of self-fertilization (spatial relationships between pollen presenting and receptive surfaces);
- SPP in dioecious taxa.

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BIO 4

Pollen dimorphism and mating systems of *Ernodea* in the Caribbean Basin

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Ernodea is thought to consist of nine species, most of which are endemic to the Bahamian Archipelago. It encompasses considerable morphological diversity, and intermediate forms have been observed in the field. As part of an extensive study to elucidate the evolution and taxonomy of the genus, breeding systems were investigated on populations of five of the taxa on Great Abaco and Great Inagua (Bahamas), and Puerto Rico. Hand pollination experiments tested for apomixis, selfing, outcrossing and inter-specific fertility. These studies suggested each taxon has a mixed-mating system, and *E. littoralis* from Great Abaco is capable of apomixis. Additionally, pollen from inter-specific crosses germinated and in most crosses led to embryo development, suggesting that the morphotypes are not reproductively isolated. On each anther, pollen grains were dimorphic in size. Pollen viability was associated with larger pollen grains while most smaller pollen grains were non-viable.

Recognition of the taxa as distinct biological species is not supportable because the morphotypes appear to be in a state of evolutionary intermediacy. Introgressive hybridization may be occurring, accounting for the lack of divergence into new species.

BIO 5

Ovule and suspensor evolution in the Rubiaceae

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All embryological characteristics of *Relbunium hypocarpium* are news, since nothing had been known about the species. The ovules are anatropous, tenuinucellate, unitegmic with both a dermal and subdermal origin. The nucellus is reduced to 2-5 elongated epidermal cells with a multicellular archesporium. The archesporium is surrounded by a very well developed chalaza tissue. Micropylar channel is present and increased by a pseudo channel wich has its origin in the destruction of the nucellar cells. Taking in account the previous reports on different members of *Rubiaceae* family, a new series of evolutionary steps involving the ovules is proposed including: reduction of the external integument, archesporium sunk into the chalaza, nucellar epidermis reduction, archesporium reduction, elongation of the nucellar epidermis, inner integument reduction, decrease in number of nucellar epidermal cells up to total loss. Evolutionary trends proposed by different authors are discussed, and a new morphological scheme is proposed for ovule differentiation .

The embryogenesis, endospermogenesis and the maturation of the fruit and seed unit were analysed. As it stands now, *R. hypocarpium* is possibly the only species mentioned as presenting naked or incomplete seeds; however, it is likely that previous interpretations were wrong and that the case presented here occurs more often in the family. The peculiarities of the seed allow suggesting that their taxonomic values within the family be reconsidered.

The metamorphosis of the suspensor is also unusual and shows a dynamics which had not yet been described previously. The haustorial suspensor was described for the Rubieae tribe and in fact also exists in *R. hypocarpium*, but this haustorial structure is temporary. When the proembryo attains the globular state, a crucial phenomenon takes place, i.e, the gradual dissolution of the pectic cement of all haustorial cells, they become independent allowing the disaggregation of the suspensor tissue, which converted into free, independent digestor cells, may act at a distance, moving around in the nutrient juice produced by lysis of the endosperm, due to the enzymatic action of these cells. The analysis of the suspensor, considering these results, shows new routes of evolution.

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BIO 6

Orbicules in the Cinchonoideae (Rubiaceae)

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Minute bodies closely associated with the tapetum were first observed by Rosanoff [*Jahrb. Wiss. Bot.* 4: 441-450 (1865)] as early as 1865. Later these acetolysis resistant particles have been called 'Ubisch bodies' after the German botanist von Ubisch, who made an important contribution to their study. Erdtman et al. [*Grana pal.* 2: 3-92 (1961)] proposed the term orbicules, which is applied here.

Orbicules are generally a few micrometers in diameter and of different shapes. They are usually associated with the degenerating secretory tapetum of the anthers in many genera of the angiosperms, both monocotyledons and dicotyledons, and many gymnosperms. The wall of the orbicules consists of sporopollenin (consequently resistant to acetolysis) and their surface pattern can be remarkably similar to the respective pollen sexine. Their functions are not yet clearly understood [Hesse, *Plant Syst. Evol.* 153: 47 (1986); Pacini & Franchi, *Plant Syst. Evol.* suppl. 7: 5 (1993)].

The first (and hitherto only) report on the occurrence of orbicules in the Rubiaceae, viz. in the genus of uncertain position *Strumpfia*, was made by Igersheim [*Nord. J. Bot.* 13: 549 (1993)]. For a list of angiosperm species reported to have orbicules see Pacini & Franchi (1993)

The present study aims (1) to draw attention to the occurrence and the possible taxonomic value of orbicules in Rubiaceae, the subfamily Cinchonoideae in particular and (2) to illustrate and discuss a few techniques to observe orbicules (*Bikkia retusiflora* serves as a model).

This preliminary study shows that orbicules are quite common in Rubiaceae. To date we have observed orbicules in many tribes of the Cinchonoideae, e.g. Cinchoneae s.s., Condamineeae, Coptosapelteae, Portlandia-group, and Rondeletieae. They also have been seen in one tribe of the Antirheoideae, viz. the Chiococceae (A. Igersheim pers. comm.).

Shape and dimension of orbicules are characteristic at species level and often there is a striking parallelism in ornamentation of orbicules and pollen sexine, e.g. in wheat pollen [El-Ghazaly & Jensen, *Grana* 24: 1-29 (1986)]. In *Bikkia retusiflora* both pollen and orbicules are beset with spines. To our knowledge orbicules have only been used for taxonomic purposes in two angiosperm families, viz. Verbenaceae (Chloanthaceae) [Raj & El-Ghazaly, *Pollen Spores* 2-3 151-166 (1987)] and Euphorbiaceae [El-Ghazaly & Chaudhary, *Grana* suppl. 2 26-32 (1993)].

Further research will focus on the morphological characterization of different orbicule-types in the Cinchonoideae. This will enable us to check the taxonomic value of their occurrence and morphology.

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BIO 7

A Phylogenetic Perspective on Heterostyly and Growth Habit Within Rubiaceae

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Among Angiosperms, the greatest number of heterostylous taxa are found within Rubiaceae [Darwin, *The diff. forms of flowers on plants of same spp.* (1877)]. This may be due in part to the size of the family: 10,400 species [Mabberley *The Plant Book* (1990)]. However, many other species rich families have no record of heterostylous members (i.e. Poaceae, Orchidaceae, and Fabaceae with the possible exception of some species of *Bauhinia*.) [(Barrett, *Evolution and function of heterostyly* (1992)]. A phylogenetic approach to determine the number of independent losses and gains of heterostyly will be used to identify evolutionary trends in this sexual system and suggest other traits associated with it.

A phylogenetic approach can also be applied to investigate the interesting and variable character of growth form in Rubiaceae. The diversity of growth forms found within Rubiaceae (i.e. trees, shrubs, lianas, and herbs) suggest that architectural and morphological traits within Rubiaceae are evolutionarily labile.

In order to answer questions concerning the evolution of heterostyly and trends in growth habit, these characters were mapped onto a phylogeny for Rubiaceae as presented by Bremer, Olsson, and Andreasen [*International Symposium on Rubiaceae* (1993)]. Bremer et al.'s phylogeny, constructed using rbcL sequence data, included about 8% (65) of the genera in Rubiaceae. To gather data on sexual systems and growth habits of the genera represented by Bremer et al.'s phylogeny, we conducted a literature survey of available floras and monographs.

The results of mapping heterostyly onto Bremer et al.'s (1993) analysis indicate that heterostyly has arisen independently at least three times within Rubiaceae at the genus level. The base of the phylogeny remains unresolved in a three branched polytomy. Two of the branches suggest that the ancestor of Rubiaceae had monomorphic flowers, but the third branch leads to *Luculia* which includes several heterostylous species. The greatest number of heterostylous taxa occur within the monophyletic group corresponding to the subfamily Rubioideae. Of the 65 genera used in Bremer et al.'s (1993) analysis, only *Bouvardia* and *Pentodon* exclusively have heterostylous species. The results of mapping growth habit onto the Rubiaceae phylogeny suggest that the ancestral state of Rubiaceae was a tree or shrub. The monophyletic groups corresponding to the subfamily Rubioideae and a second clade containing the monophyletic group corresponding to the subfamily Ixoroideae and members of Cinchonoideae both exhibit multiple evolutionary gains and losses of all growth habits. Within the clade composed of Ixoroideae and members of Cinchonoideae there are at least four independent evolutionary changes to the herbaceous growth habit in this predominantly woody clade. Interestingly, the clade corresponding to Rubioideae not only includes a majority of the heterostylous taxa within Rubiaceae, but also contains the majority of the herbaceous taxa.

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BIO 8

Growth rings in wood of tropical Rubiaceae

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More and more political decisions are in need of a scientific diagnosis of the relationship between human culture and nature. Ecology aims to meet these needs. As such, the relevance of ecology is nowadays quickly increasing worldwide.
However, one of the major constraints for the functions of ecology in the process of political decision making, is that very often useful data are missing. Indeed, even at present it is not always possible to establish a large and dense network of sophisticated sensors. Therefore, ecology looks for valuable information in natural structures, such as sediment layers, polar ice caps and plant tissues. Especially the analysis of growth layers in wood is gaining attention among ecologists. The decisive advantage is that trees and shrubs are present in nearly all terrestrial plant formations. If it is possible to distract everywhere information from the xylem structure, than a dense and worldwide network of sensors and registration means can be provided for ecology [Beeckman, *Biologisch Jaarboek, Dodonaea*, 61, 36-56 (1993)].
The scientific discipline studying growth patterns in wood, especially tree ring features, and their relation with the environment, is called dendrochronology.
Growth patterns in tropical wood have until now not been studied systematically. An important reason is the often not justified belief that all tropical trees grow continuously without forming rings in their lignified tissues. However, ring patterns in the wood of tropical species as a result of periodically slower cambial activity, have been observed frequently. For an overview see Jacoby [*IAWA Bulletin n.s.* 10 (2): 99-108 (1989)].
To make a catalogue of Rubiaceae revealing growth rings and evaluate the Rubiaceae potentiality for dendrochronological investigation, thin sections of wood samples of the xylarium of the Royal Museum of Central Africa have been observed. They are described according to Carlquist [*Springer Series in Wood Science, Comparative Wood Anatomy*, 436 pp. (1988)] and the IAWA-standard list of wood anatomical characters [Wheeler, E., Baas, P. & Gasson, P.E. (Eds.), *IAWA Bulletin n.s.* 10 (3): 219-332 (1989)]. To correlate the growth ring information to general environmental conditions, as well habitat qualifications have been listed.
Several Rubiaceae specimen are found to show distinct growth rings: 25 % of the examined samples exhibit tree rings. Ring borders could be formed as well by changes in fibre walls as by vessel arrangement and marginal parenchyme.
The influence of habitat has been proved.

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BIO 9

Phytoliths in wood of Rubiaceae

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Phytoliths are microscopic mineral particles deposited within and around the cells of many plant taxa. Significant levels of silica have for instance been found in lignified tissues of many trees and shrubs, but especially Poaceae, Cyperaceae and Equisetaceae are known as phytolith accumulators. All parts of these families may produce phytoliths, however subterranean parts for instance contain less than aerial structures. After putrefaction of the organic material, phytoliths mainly are precipitated *in situ*. This provides an interesting factor for soil scientists studying phytoliths as indicators of palaeosoils and palaeovegetation. As such there is growing evidence that phytolith studies can make a contribution to the verification of archaeological hypotheses. Some botanical studies focus mainly on physiological functions of phytoliths in living plants.

The proposed research intend to verify hypotheses on the systematic value of mineral inclusions in lignified tissues of Rubiaceae.

The test set consists of wood samples of *Adina, Hallea, Mytragina and Nauclea*. Thin sections from the xylarium of the Royal Museum for Central Africa, Tervuren, have been examined microscopically. Presence/absence, abundance and anatomical localisation of possible cellular inclusions are checked. These observations are combined with other anatomical features.

This approach is hampered by important constraints dealing with as well the methodological as the inference dimension. How to identify precisely crystalline structures ? Are absence/presence and abundance phenomena taxon specific or do they express environmental conditions ? How to establish precisely the nature of the accumulations (silica, calcium oxalate,...) ?

However, the investigation has some promising preliminary results. Nevertheless, the robustness of the method should be proved in the future.

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BIO 10

Studies on the pollen of South-American species of *Borreria*

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The object of this work is to provide elements that could help the establishment of phylogenetic relations between the species belonging to the genus *Borreria*. This palynological study includes 50 American species of *Borreria* and also 4 other species of *Diodia* and one of *Hemidiodia*, that are subordinated to *Borreria* (Bacigalupo and Cabral). Pollen morphology in *Borreria* shows great variability, however most of the species have spheroidal, medium-sized (25-50 µm) grains, with tectate-perforate exine. According to the apertures, eventhough the stephano-colporate grains are the predominant type; they present a great variation respect to the ectoapertures o colpus length and orientation, also the endoapertures shapes, that can be laterally joined, sometimes. About 25 % of the studied species have porate grains. The number of apertures ranges from 3 to 18.

The sequencial transformation of apertures is analyzed and correlated with the number of apertures and also, with the grain's shape and size. A tentative evolutionary sequence is proposed, that it shows the following tendencies:
1. zonal apertures towards global apertures
2. shortening of colpi or ectoapertures (long colpus - short colpus - pore)
3. narrowing of the endoapertures (zonorate apertures - lalongate - lolongate)
4. increse of the number of apertures (few apertures: 3 or 4 - many apertures: 18)

These tendencies go with an evolutionary sense that increase towards the relation P/E=1. Upon this base, pollen grains types are established; these types include species that can also have other morphological and floral characters in common.

BIO 11

Pollen morphology of the tribe Pavetteae (subfamily Ixoroideae)

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In order to gather data for a phylogenetic study of the tribe Pavetteae (subfamily Ixoroideae), pollen morphology of ca. 80 species of its 20 genera was investigated. The grains were acetolysed and studied using light and scanning electron microscopy. Furthermore, grains were broken to examine the nature of the compound apertures, which are typical for the Rubiaceae.

The tribe Pavetteae is stenopalynous and characterized by the 3-zonocolporate pollen type which is dominant in the family. Only rarely four apertures occur. The exine is typically columellate and either semi-tectate (reticulate) or tectate (perforate). Supratectal sculpturing elements are only present in a few genera, e. g. *Pavetta*.
In the present study, pollen features (including information on the compound aperture) are described for each genus of the Pavetteae.
Morphological variation is small within genera (e. g. *Ixora*) and palynological data therefore have a poor taxonomic value below generic level. The genus *Rutidea*, however, forms an exception to this: here the exine varies from species to species (from widely meshed reticulate to almost closed tectum).

The generic variation observed is evaluated and interpreted in the light of the macrosystematics of the tribe.

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BIO 12

Pollen morphology of the *Isertieae* (*Cinchonoideae - Rubiaceae*) and systematic implications

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As part of a pollen morphological study of the subfamily Cinchonoideae a palynological investigation of the pantropical tribe Isertieae is presented. This study wants to document the palynological variation in the Isertieae as exhaustively as possible, not only in the selection of specimens but also in maximizing the number of characters in search of 'predictive' characters with taxonomic value in the study group. The implications of our palynological findings on the systematics of the Isertieae are discussed.

The Isertieae consists of 22 genera (+ eventually *Aoranthe* and *Streblosiopsis*) with a total species number of ± 450. Pollen of the following genera has been observed (studied species/total species): *Aoranthe* (2/5), *Aphaenandra* (1/2), *Ecpoma* (1/6), *Gonzalagunia* (3/35), *Gouldia* (3/3), *Heinsia* (4/5), *Isertia* (5/14), *Mussaenda* (4/190), *Mycetia* (4/25), *Pseudomussaenda* (2/5), *Pseudosabicea* (2/12), *Raritebe* (1/1), *Sabicea* (2/120), *Schizomussaenda* (1/1), *Stipularia* (2/2), and *Temnopteryx* (1/1). Heterodistyly occurs in eleven genera whether or not accompanied by pollen polymorphism.

The tribe proved to be eurypalynous. Although the sexine pattern varies only from tectate perforate over microreticulate to reticulate we observed a great variability in the complex aperture-system. Apertures are mainly compound (two or three non-congruent apertures in different wall layers). The colporate pollen type is most common, colpoidorate grains characterize *Isertia* and some species of *Pseudosabicea* and *Sabicea*. Porate pollen is restricted to *Stipularia* and some species of *Pseudosabicea*. *Ecpoma*, however, has simple colpus shaped apertures. Aperture number is often variabel within one species. 3 or 4 apertures are most common.The fascinating generic variation in the nature and patterns of the endexine confirms our idea about the high systematic value of endosculptures in Rubiaceae [Huysmans, Robbrecht & Smets, *11. Symp. Morph., Anat., Syst. Abstr.* 66 (1993)].

A pollen dimorphism that is correlated with heterodistyly is not universally present in the studied genera. If so, rather inconspicuous differences in aperture number (e.g. *Sabicea*) or sexine pattern (e.g. *Pseudosabicea*) are observed between the two morphs.

BIO 13

Endexine ornamentation in pollen of *Psychotrieae* (*Rubiaceae - Rubioideae*)

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The difficult delimitation of the genera of the *Psychotrieae* is one of the main taxonomic problems in the *Rubioideae*. Petit [*Bull. Rijksplantentuin Bruss.* 34: 1-228 (1964)], Verdcourt [*Kew Bull.* 30: 267 (1975)] and Robbrecht [*Bull. Mus. Natn. Hist. Nat., Paris, 4e serie, sect. B, Adansonia* 4: 341-349 (1990)] made new generic definitions in the African *Psychotrieae* based on fruit morphological characters. A profound pollen morphological study of this eurypalynous tribe is still lacking, although Robbrecht [*Opera Bot. Belg.* 1: 1-271 (1988)] and Johansson [*Opera Bot.* 115: 1-71 (1992)] stated that it might be one of the most promising research topics in the *Rubiaceae*.

A pollen morphological study of woody African *Psychotrieae* (*Chassalia*, *Chazaliella*, *Psychotria*) and the genus pair *Gaertnera* and *Pagamea* was undertaken. Pollen grains from 22 species were acetolysed, broken by shaking with glass beads and observed by LM and SEM. Previous palynological studies on *Psychotrieae* never included observations of the inside of the pollen, although recent studies emphasized that characters at the inside of the exine have, at least in the *Rubiaceae*, a great systematic value.

The endexine ornamentation showed useful features to distinguish between the studied genera. *Psychotria* has pollen with many endocracks. *Chazaliella* has a nearly smooth to rough endexine without endocracks. Endocracks are also absent in pollen grains of *Chassalia*. *Gaertnera* and its neotropical counterpart *Pagamea* has pollen with endocracks and remarkable crescent shaped thickenings which we consider as costae, although the thickenings are not completely surrounding the coumpound apertures. These costae are probably apomorphic and are an important argument to put the two genera in a separated subtribe *Gaertnerinae* [Jansen, Robbrecht, Beeckman & Smets, *Bot. Acta*: in press].

Our palynological observations thus confirm the generic delimitation of the African genera of the *Psychotrieae*. Pollen morphology and especially observations on the endexine present powerful characters and therefore should form an integral part of every future systematic investigation of the *Psychotrieae*.

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BIO 14

Camille Vermoesen (1882-1922), a pioneer in systematic pollen morphology

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About 1920, a staff member of the National Botanic Garden of Belgium, C. Vermoesen, became interested in systematic pollen morphology, no doubt because of his great experience with microscopy (embryology and mycology in particular). He started inter alia a critical investigation of the '*Randia-Gardenia*' complex in the Rubiaceae, mainly its tropical African representatives.

In 1922, he died suddenly. He left only one palynological publication, a preliminary research report, in Dutch, reflecting the content of a lecture; he herein proposed a division of the artificial genus *Randia*, based on general morphology plus pollen observations. The Garden's archives contain a small card file with unedited pollen morphological observations (drawings, pollen descriptions etc.); many other observations are kept with the specimens in the herbarium.

The present poster illustrates Vermoesen's pioneering work, using a translated fragment of the sole publication, proposing
(i) the transfer of the central African '*Randia physophylla*' to *Gardenia*, a conclusion still followed today, and
(ii) a division of *'Randia'* over four genera, now accepted as *Aidia, Rothmannia, Adenorandia* and *Euclinia*.

An example of unedited observations is also included, viz. Vermoesen's morphological and palynological analysis of a specimen of *'Randia rudis'*, anticipating the description of the southern African monospecific genus *Coddia* by Verdcourt in 1981.

Vermoesen's pollen preparations were not permanent. He observed grains swollen either in water or in chloral hydrate.

PAL 10

Flora Malesiana Rubiaceae

Coordinating author: Dr Christopher F. Puttock
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The Flora Malesiana project covers an area of the palaeotropics centred on Indonesia, with Sumatra and Peninsula Malaya in the west, The Philippines in the north and New Guinea in the east.

Over the years, gradual headway has been made in bringing a Rubiaceae flora treatment towards a reality. During the last decade relatively few genera have been revised, and many others await critical review. Even with a long lead time before predicted completion of the flora treatment, say 15-20 years, some of the larger genera may present challenges that will be insuperable.

It is estimated that there are more than 1500 species in 150 genera for the region. Some 75 genera have more than 10 species. About 10% of these have over fifty species. Thirty botanists have indicated their willingness to be involved in revisions and/or flora writing of 75 genera, accounting for about 30% of the total number of species currently known. Only a small number of genera have had generic treatments published.

Two areas that researchers may be able to contribute:

1) There is no comprehensive checklist of known taxa. Researchers may have valuable unpublished knowledge that would contribute to a better understanding of the number of species in the region.
2) The many genera remaining to be investigated contain small projects to larger revisions. Researchers are encouraged to consider these as fertile field for their students and themselves.

An avenue of endeavour, largely unexplored, is that of extending cooperation and collaboration with students/botanists of the Malesian region, for whom the finished product will have its greatest impact. It is anticipated that such small team collaborations, focusing on the remaining genera, will be viewed favourably by potential sources of financial support.

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EVR 10

Proposed circumscription of the tribes Condamineeae, Catesbaeeae and Chiococceae (Rubiaceae) based on morphological characters

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Based on and molecular and morphological data the subtribe Portlandiinae (Cinchonoideae, Condamineeae), a group of about 13 genera, has recently been transferred from the tribe Condamineeae to the tribe Chiococceae. Through a cladistic analysis involving 156 species of 44 genera (ail genera from the Condamineeae and Catesbaeeae sensu Hooker and selected ones from the Chiococceae, Rondeletieae, Cinchoneae, and Coffeeae), the present study tests this recent transfer as well as definitions of the tribes involved and associated hypotheses of character evolution (fruit and seed types). Forty-four morphological characters with 160 states have been scored.

The Chiococceae appears to be monophyletic without the Portlandiinae and is maintained with the original description suggested by Hooker and maintained by Robbrecht. The Portlandiinae is instead included within the Catesbaeeae, for which a revised tribal delimitation is presented.

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Appendix

Gentianales in the greenhouses of the National Botanic Garden of Belgium

Viviane LEYMAN & Thierry VANDERBORGHT,
National Botanic Garden of Belgium

The families Apocynaceae, Asclepiadaceae, Gentianaceae, Loganiaceae and Rubiaceae are included in this checklist. The first part gives an enumeration of plants per greenhouse. In the second part alphabetical lists are given by families.

The following refers to the placement in the greenhouses (fig. 1):
PP Plant Palace, followed bij the number or the letter of its house;
KK Nursery complex, followed by the number of its house.

1. Plants arranged by greenhouse

PPA, house subtropical Asia
Apocynaceae: *Trachelospermum asiaticum, Trachelospermum jasminoides*
Rubiaceae: *Coprosma* 'Coppershine', *Coprosma baueri*, *Coprosma baueri* 'Picturata'

PPC, house tropical Asia
Apocynaceae: *Kopsia fruticosa, Tabernaemontana coronaria* 'Flore Pleno'
Asclepiadaceae: *Dischidia bengalensis, Hoya carnosa*
Rubiaceae: *Psychotria maingayi*

PPD, house tropical Asia
Apocynaceae: *Beaumontia grandiflora, Cerbera manghas, Chonemorpha macrophylla, Kopsia arborea, Kopsia fruticosa, Melodinus monogynus, Melodinus tournieri*
Rubiaceae: *Catunaregam spinosa, Duperrea pavettaefolia, Ixora* (Coccinea-hybrid) 'Calycifolia', *Ixora chinensis* 'Alba'

PPE, house tropical America
Apocynaceae: *Allamanda cathartica, Dipladenia* (Hybrid) 'Rosacea'
Rubiaceae: *Hoffmannia ghiesbreghtii, Psychotria brasiliensis, Rondeletia odorata*

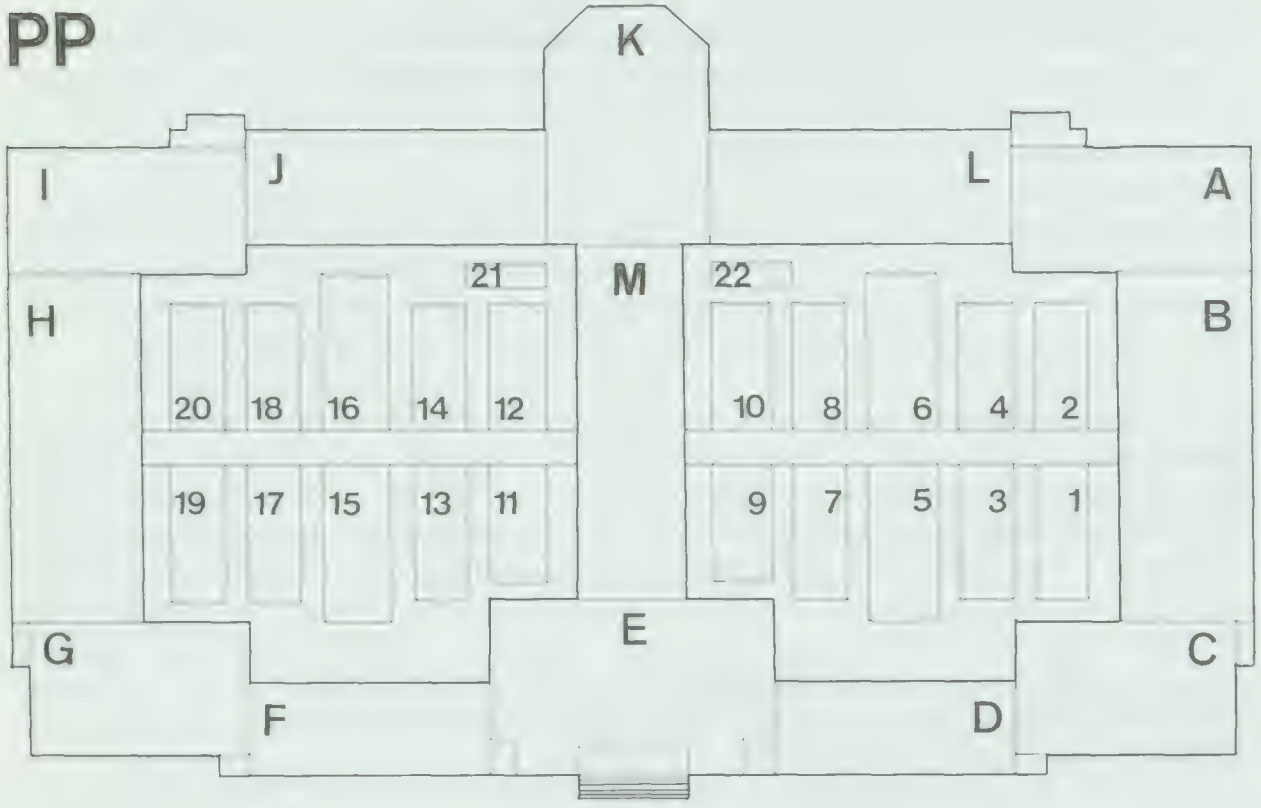
PPF, house tropical Africa
Apocynaceae: *Alstonia boonei, Hunteria eburnea, Landolphia klainei, Mascarenhasia arborescens, Rauvolfia caffra, Saba comorensis*
Asclepiadaceae: *Cryptostegia grandiflora*
Loganiaceae: *Strychnos congolana*
Rubiaceae: *Euclinia longiflora, Mitragyna rubrostipulata, Oxyanthus formosus, Pentas lanceolata* '...', *Psilanthus ebracteolatus, Psychotria calva, Psychotria kirkii* var. *tarambassica, Psychotria lucens* var. *lucens, Rothmannia fischeri, Schumanniophyton magnificum, Vangueria edulis*

PPG, house tropical Africa
Apocynaceae: *Funtumia africana, Funtumia elastica, Landolphia dawei, Landolphia klainei, Landolphia thollonii, Pleiocarpa pycnantha, Saba comorensis, Strophanthus ecaudatus, Strophanthus hispidus, Strophanthus intermedius, Strophanthus preussii* var. *scabridulus*, unnamed specimen
Asclepiadaceae: *Stephanotis floribunda*
Rubiaceae: *Coffea arabica, Coffea arabica* 'Polysperma', *Coffea arabica* var. *abyssinica, Coffea arnoldiana, Coffea aruwinaiensis, Coffea canephora, Coffea canephora* var. *kouilouensis, Coffea canephora* var. *sankuruensis, Coffea dewevrei, Coffea dybowskii, Coffea excelsa, Coffea liberica, Coffea liberica* var. *dewevrei, Coffea liberica* var. *liberica, Coffea mauritiana, Coffea myrtifolia, Coffea racemosa, Massularia acuminata, Oxyanthus racemosus, Psychotria peduncularis*

PPH, house subtropical Africa
Apocynaceae: *Acokanthera oblongifolia, Acokanthera rotundata, Carissa bispinosa, Nerium oleander, Nerium oleander* 'Atropurpureum', *Nerium oleander* 'Variegatum', *Nerium oleander* '...', *Wrightia natalensis*
Asclepiadaceae: *Ceropegia stapeliiformis, Ceropegia woodii* subsp. *woodii, Echidnopsis cereiformis, Stapelia variegata, Stapelia wilmaniae*
Rubiaceae: *Gardenia cornuta, Gardenia thunbergia, Mitriostigma axillare, Pavetta abyssinica, Pentas lanceolata* 'Rubra'

PPI, house subtropical America
Asclepiadaceae: *Asclepias curassavica, Matelea trianae*
Rubiaceae: *Bouvardia* 'Alba'

Fig. 1 — Groundplan of the Plant Palace (PP) and the nursery complex (KK)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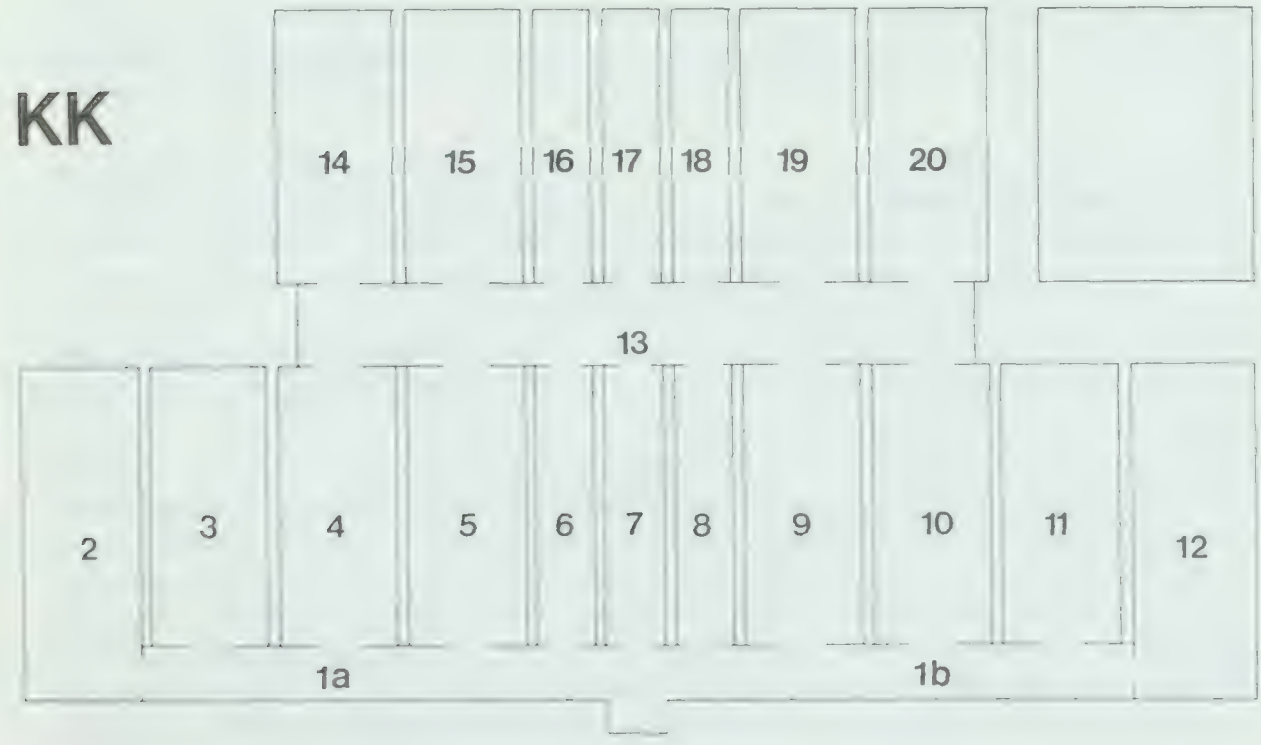
KK
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1b

PPJ, house tropical economic plants

Apocynaceae: *Catharanthus roseus, Funtumia elastica, Landolphia dawei, Landolphia klainei, Rauvolfia tetraphylla, Rauvolfia vomitoria, Strophanthus arnoldianus, Strophanthus hispidus, Strophanthus preussii, Thevetia peruviana*
Asclepiadaceae: *Asclepias curassavica*
Loganiaceae: *Strychnos spinosa*
Rubiaceae: *Cinchona pubescens, Coffea arabica, Coffea arabica* 'Catura', *Coffea arabica* 'de Miberisi', *Coffea arabica* 'La Jamaica', *Coffea arabica* 'Nana', *Coffea arabica* 'Sans Ramon', *Coffea arabica* 'Violette', *Coffea* x *arabusta, Coffea arnoldiana, Coffea canephora, Randia nitida, Vangueria edulis, Vangueria infausta*

PPK, Victoria house

Apocynaceae: *Allamanda cathartica, Plumeria rubra, Tabernaemontana africana*
Asclepiadaceae: *Dischidia pectenoides*
Rubiaceae: *Euclinia longiflora, Hoffmannia refulgens, Hoffmannia regalis, Hydnophytum formicarum, Ixora chinensis, Ixora chinensis* 'Rosea', *Myrmecodia armata, Myrmecodia echinata*

PPL, house subtropical economic plants

Apocynaceae: *Aspidosperma quebracho-blanco, Carissa edulis, Nerium oleander*
Rubiaceae: *Gardenia thunbergia*

PPM, house tropical America

Apocynaceae: *Plumeria bicolor, Plumeria rubra, Plumeria sericifolia, Thevetia peruviana*
Loganiaceae: *Strychnos schultesiana*
Rubiaceae: *Cinchona pubescens, Genipa americana, Guettarda uruguensis, Hamelia patens, Hoffmannia ghiesbreghtii* 'Variegata', *Hoffmannia regalis, Psychotria brasiliensis, Rondeletia odorata*

PP1, house with succulents

Apocynaceae: *Pachypodium baronii* var. *baronii, Pachypodium rosulatum* var. *gracilius*
Asclepiadaceae: *Caralluma ango, Caralluma baldratii, Caralluma burchardii, Caralluma burchardii* var. *maura, Caralluma dummeri, Caralluma edulis, Caralluma europaea* var. *affinis, Caralluma foetida, Caralluma foulcheri-delboscii, Caralluma frerei, Caralluma gracilipes, Caralluma gracilipes* subsp. *arachnoidea, Caralluma hesperidum, Caralluma hottentotorum, Caralluma joannis, Caralluma keithii, Caralluma munbyana, Caralluma parviflora, Caralluma priogonium, Caralluma schweinfurthii, Caralluma tubiformis, Caralluma turneri, Ceropegia* sp., *Ceropegia ampliata, Ceropegia arabica, Ceropegia armandii, Ceropegia barklyi, Ceropegia denticulata* var. *denticulata, Ceropegia devecchii, Ceropegia devecchii* var. *adelaidae, Ceropegia dichotoma, Ceropegia distincta* subsp. *haygarthii, Ceropegia evelynae, Ceropegia fusiformis, Ceropegia grandis, Ceropegia hians, Ceropegia juncea, Ceropegia krainzii, Ceropegia linearis, Ceropegia nilotica, Ceropegia nilotica* var. *nilotica, Ceropegia radicans, Ceropegia robynsiana, Ceropegia* x *rothii, Ceropegia sandersonii, Ceropegia stapeliiformis, Ceropegia succulenta, Ceropegia variegata, Ceropegia woodii, Ceropegia woodii* x *barklyi, Ceropegia woodii* subsp. *debilis, Ceropegia*

woodii subsp. *woodii*, *Decabelone grandiflora*, *Duvalia elegans*, *Duvalia elegans* var. *seminuda*, *Duvalia reclinata*, *Duvaliandra dioscoridis*, *Echidnopsis cereiformis*, *Echidnopsis dammaniana*, *Echidnopsis radians*, *Echidnopsis repens*, *Edithcolea* sp., *Edithcolea grandis*, *Fockea sinuata*, *Hoodia gordonii*, *Hoodia macrantha*, *Hoya australis*, *Hoya carnosa*, *Hoya carnosa* 'Compacta', *Hoya carnosa* 'Exotica', *Hoya carnosa* 'Motaskae', *Hoya carnosa* 'Variegata', *Hoya globulosa* x *higginsii*, *Hoya linearis*, *Hoya multiflora*, *Huernia* sp., *Huernia aspera*, *Huernia boleana*, *Huernia confusa*, *Huernia insigniflora*, *Huernia keniensis*, *Huernia kenyensis* var. *nairobiensis*, *Huernia keniensis* var. *quarta*, *Huernia kennedyana*, *Huernia loesseneriana*, *Huernia macrocarpa*, *Huernia macrocarpa* var. *penzigii*, *Huernia macrocarpa* var. *schweinfurthii*, *Huernia oculata*, *Huernia pendula*, *Huernia purpusii*, *Huernia saudi-arabica*, *Huernia schneiderana*, *Huernia schneiderana* 'Cristata', *Huernia striata*, *Huernia zebrina*, *Ophionella arcuata* var. *mirkinii*, *Orbea ciliata*, *Orbeopsis gerstneri* subsp. *elongata*, *Piaranthus* sp., *Piaranthus foetidus*, *Piaranthus parvulus*, *Piaranthus pulcher*, *Piaranthus ruschii*, *Sarcostemma*, *Sarcostemma stipitaceum*, *Sarcostemma viminale*, *Stapelia* sp., *Stapelia albicans*, *Stapelia ambigua* var. *fulva*, *Stapelia arnotii*, *Stapelia desmetiana*, *Stapelia* x *discolor*, *Stapelia erectiflora*, *Stapelia flavirostris*, *Stapelia gemmiflora*, *Stapelia gettlettii*, *Stapelia gigantea*, *Stapelia gigantea* var. *pallida*, *Stapelia glabricaulis*, *Stapelia* x *hamburyana*, *Stapelia hirsuta* var. *patula*, *Stapelia lepida*, *Stapelia longidens*, *Stapelia* x *luxurians*, *Stapelia nobilis*, *Stapelia pasadenensis*, *Stapelia pulchella* 'Cristata', *Stapelia* x *rectiflora*, *Stapelia tsomoensis*, *Stapelia variegata*, *Stapelia variegata* var. *atrata*, *Stapelia variegata* var. *marmorata*, *Stapelia variegata* var. *pallida*, *Stapelia variegata* var. *picta*, *Stapelia variegata* var. *planiflora*, *Stapelia variegata* var. *trisulca*, *Stapelia variegata* var. *variegata*, *Stapelia wilmaniae*, *Stapelianthus decaryi*, *Stapelianthus keraudreniae*, *Trichocaulon clavatum*, *Tridentea longipes*, *Tridentea marientalensis*
Apocynaceae: *Adenium* sp.

PP2, house with succulents
Asclepiadaceae: *Ceropegia ballyana*, *Ceropegia robynsiana*, *Ceropegia sandersonii*

PP5, house subtropical Asia (and other)
Apocynaceae: *Carissa carandas*
Rubiaceae: *Coprosma 'Coppershine'*, *Coprosma kirkii* 'Variegata', *Coprosma repens*, *Emmenopterys henryi*, *Luculia gratissima* x *tsetensis*, *Nertera cunninghamii*

PP6, house with succulents
Apocynaceae: *Pachypodium lamerei*

PP8, house tropical America (and other)
Apocynaceae: *Dipladenia* (Hybrid) 'Rosacea', *Dipladenia atropurpurea*, *Tabernaemontana heterophylla*
Rubiaceae: *Hamelia versicolor*, *Psychotria carthagenensis*, *Rosenbergiodendron formosum*

PP9, house tropical America
Apocynaceae: *Allamanda neriifolia*, *Allamanda violacea*, *Peltastes peltatus*, *Prestonia quinquangularis*, *Rauvolfia tetraphylla*

Asclepiadaceae: *Asclepias curassavica*
Rubiaceae: *Coccocypselum guianense, Geophila macropoda, Geophila repens, Hoffmannia ghiesbreghtii, Hoffmannia ghiesbreghtii* 'Variegata', *Hoffmannia refulgens, Hoffmannia regalis, Rondeletia odorata, Rudgea macrophylla*

PP10, house tropical Asia
Apocynaceae: *Alstonia scholaris, Alyxia ruscifolia, Ochrosia elliptica, Rauvolfia serpentina, Strophanthus dichotomus, Strophanthus divaricatus, Tabernaemontana coronaria* 'Flore pleno', *Tabernaemontana crispa*
Asclepiadaceae: *Calotropis procera, Dischidia bengalensis, Dischidia pectenoides, Hoya* sp., *Hoya angustifolia, Hoya bella, Hoya carnosa* '---', *Hoya imperialis, Hoya multiflora, Hoya obovata, Hoya purpureofusca*
Loganiaceae: *Strychnos nux-vomica*
Rubiaceae: *Ixora* sp., *Ixora chinensis, Ixora chinensis* 'Rosea', *Ixora coccinea, Ixora lutea, Morinda citrifolia, Morinda lucida, Paederia foetida, Psychotria maingayi, Serissa foetida* '---'

PP17, orchid house and other
Rubiaceae: *Hydnophytum formicarum, Myrmecodia armata, Myrmecodia echinata*

PP18, house tropical Africa
Apocynaceae: *Acokanthera oppositifolia, Aphanostylis mannii, Baissea leonensis, Baissea multiflora, Callichilia barteri, Carissa bispinosa, Catharanthus roseus* 'Alba', *Cerbera venenifera, Funtumia elastica, Hedranthera barteri, Isonema smeathmannii, Landolphia heudelotii, Landolphia owariensis, Picralima nitida, Pleiocarpa mutica, Rauvolfia vomitoria, Strophanthus gratus, Strophanthus hispidus, Strophanthus kombe, Tabernaemontana crassa, Tabernaemontana glandulosa, Tabernanthe iboga, Voacanga africana*
Asclepiadaceae: *Cryptostegia madagascariensis, Secamone afzelii, Tylophora laevigata*
Loganiaceae: *Strychnos madagascariensis, Strychnos millepunctata, Strychnos potatorum, Strychnos spinosa*
Rubiaceae: *Aidia micrantha, Catunaregam spinosa, Coffea arabica* 'Catura', *Coffea arabica* 'Minima', *Coffea arabica* 'Nana', *Coffea laurifolia, Cremaspora triflora, Didymosalpinx norae, Feretia aeruginescens, Fernelia buxifolia, Morinda* sp., *Mussaenda erythrophylla, Oxyanthus formosus, Pouchetia baumanniana, Psilanthus mannii, Psychotria kirkii, Psychotria nigrapunctata, Psychotria verschuerenii* var. *reducta, Rothmannia manganjae, Tarenna borbonica, Vangueria infausta* var. *virescens, Vangueriopsis lanciflora*

PP20, house subtropical Africa and America
Apocynaceae: *Carissa macrocarpa, Mandevilla laxa, Nerium oleander* 'Atropurpureum'
Asclepiadaceae: *Gonolobus niger, Oxypetalum caeruleum*
Loganiaceae: *Gelsemium sempervirens*
Rubiaceae: *Bouvardia* 'Alba', *Bouvardia* 'Rosea', *Bouvardia* 'Rubra', *Bouvardia ternifolia, Gardenia cornuta, Gardenia spathulifolia, Gardenia thunbergia, Mitriostigma axillare, Nertera granadensis*

PP22, house with succulents
Asclepiadaceae: *Cynanchum marnierianum, Decabelone grandiflora, Dictyanthus stapeliaeflorus, Raphionacme welwitschii, Trichocaulon* sp., *Trichocaulon dinteri*
Apocynaceae: *Adenium obesum* subsp. *multiflorum, Adenium oleifolium, Pachypodium densiflorum, Pachypodium densiflorum* var. *densiflorum, Pachypodium lamerei, Pachypodium rosulatum* var. *horombense, Pachypodium succulentum*

PP23, gallery
Asclepiadaceae: *Oxypetalum caeruleum*

KK3
Apocynaceae: *Strophanthus speciosus, Trachelospermum* 'Shirofu-Chirimen'
Rubiaceae: *Galium hypocarpium, Nertera* cf. *granadensis*

KK7
Rubiaceae: *Coprosma kirkii* 'Variegata', *Leptactina leopoldi-secundi, Leptactina pynaertii*

KK9
Apocynaceae: *Tabernaemontana* sp.
Rubiaceae: *Chassalia* sp., *Paederia* sp.

KK17
Apocynaceae: *Catharanthus roseus*
Rubiaceae: *Coprosma* 'Coppershine', *Tricalysia junodii* var. *kirkii, Pentas lanceolata, Pentas lanceolata* 'Rubra', *Pentas lanceolata* '...'

KK18
Apocynaceae: *Pterotaberna inconspicua*
Gentianaceae: *Irlbachia* sp.
Rubiaceae: *Cephaelis ipecacuanha, Duperrea pavettaefolia, Gardenia ternifolia* subsp. *ternifolia, Hillia parasitica, Keetia multiflora, Posoqueria longiflora*

KK19
Apocynaceae: *Acokanthera oblongifolia, Prestonia quinquangularis*
Asclepiadaceae: *Cryptostegia grandiflora*
Rubiaceae: *Coccocypselum guianense, Hoffmannia ghiesbreghtii, Ixora* (Coccinea-hybrid) 'Shawii', *Ixora chinensis*

2. Alphabetical list

The list is arranged by families. Names are followed by a greenhouse number.

Apocynaceae

Acokanthera oblongifolia (Hochst.) Codd	PPH, KK19
Acokanthera oppositifolia (Lam.) Codd	PP18
Acokanthera rotundata (Codd) Kupicha	PPH
Adenium sp.	PP1
Adenium obesum (Forssk.) Roem. & Schult. subsp. *multiflorum* (Klotzsch) Codd	PP22
Adenium oleifolium Stapf	PP22
Allamanda cathartica L.	PPE, PPK
Allamanda neriifolia Hook.	PP9
Allamanda violacea Gardner & Fielding	PP9
Alstonia boonei De Wild.	PPF
Alstonia scholaris (L.) R.Br.	PP10
Alyxia ruscifolia R.Br.	PP10
Aphanostylis mannii (Stapf) Pierre	PP18
Aspidosperma quebracho-blanco Schltdl.	PPL
Baissea leonensis Benth.	PP18
Baissea multiflora A.DC.	PP18
Beaumontia grandiflora (Roxb.) Wall.	PPD
Callichilia barteri Stapf	PP18
Carissa bispinosa (L.) Desf. ex Brenan	PPH, PP18
Carissa carandas L.	PP5
Carissa edulis Vahl	PPL
Carissa macrocarpa (Eckl.) A.DC.	PP20
Catharanthus roseus (L.) G.Don	PPJ, KK17
Catharanthus roseus (L.) G.Don 'Alba'	PP18
Cerbera manghas L.	PPD
Cerbera venenifera (Poir.) Steud.	PP18
Chonemorpha macrophylla G.Don	PPD
Dipladenia (Hybrid) 'Rosacea'	PP8, PPE
Dipladenia atropurpurea DC.	PP8
Funtumia africana Stapf	PPG
Funtumia elastica Stapf	PPG, PPJ, PP18
Hedranthera barteri (Hook.f.) Pichon	PP18
Hunteria eburnea Pichon	PPF
Isonema smeathmannii Roem. & Schult.	PP18
Kopsia arborea (Blume) G.Don	PPD
Kopsia fruticosa A.DC.	PPC, PPD
Landolphia dawei Stapf	PPG, PPJ
Landolphia heudelotii A.DC.	PP18
Landolphia klainei Pierre	PPF, PPG, PPJ

Landolphia owariensis Beauverd	PP18
Landolphia thollonii Dewèvre	PPG
Mandevilla laxa (Ruiz & Pav.) Woodson	PP20
Mascarenhasia arborescens A.DC.	PPF
Melodinus monogynus Roxb.	PPD
Melodinus tournieri Pierre	PPD
Nerium oleander L.	PPH, PPL
Nerium oleander L. '---'	PPH
Nerium oleander L. 'Atropurpureum'	PP20, PPH
Nerium oleander L. 'Variegatum'	PPH
Ochrosia elliptica Labill.	PP10
Pachypodium baronii Const. & Bois var. *baronii*	PP1
Pachypodium densiflorum Baker	PP22
Pachypodium densiflorum Baker var. *densiflorum*	PP22
Pachypodium lamerei Drake	PP6, PP22
Pachypodium rosulatum Baker var. *gracilius* Perr.	PP1
Pachypodium rosulatum Baker var. *horombense* (Poiss.) G.D.Rowley	PP22
Pachypodium succulentum (L.f.) A.DC.	PP22
Peltastes peltatus (Vell.) Woodson	PP9
Picralima nitida T.Durand & H.Durand	PP18
Pleiocarpa mutica Benth.	PP18
Pleiocarpa pycnantha (K.Schum.) Stapf	PPG
Plumeria bicolor Ruiz & Pav.	PPM
Plumeria rubra L.	PPK, PPM
Plumeria sericifolia C.Wright	PPM
Prestonia quinquangularis (Jacq.) Spreng.	PP9, KK19
Pterotaberna inconspicua Stapf	KK18
Rauvolfia caffra Sond.	PPF
Rauvolfia serpentina (L.) Benth.	PP10
Rauvolfia tetraphylla L.	PP9, PPJ
Rauvolfia vomitoria Afzel.	PPJ, PP18
Saba comorensis (Bojer) Pichon	PPF, PPG
Strophanthus arnoldianus De Wild. & T.Durand	PPJ
Strophanthus dichotomus DC.	PP10
Strophanthus divaricatus G.Don	PP10
Strophanthus ecaudatus Rolfe	PPG
Strophanthus gratus (Wall. & Hook. ex Benth.) Baill.	PP18
Strophanthus hispidus DC.	PPG, PPJ, PP18
Strophanthus intermedius Pax	PPG
Strophanthus kombe Oliv.	PP18
Strophanthus preussii Engl. & Pax	PPJ
Strophanthus preussii Engl. & Pax var. *scabridulus* Monach.	PPG
Strophanthus speciosus (N.B.Ward & Harv.) Reber	KK3
Tabernaemontana sp.	KK9

Tabernaemontana africana Hook.	PPK
Tabernaemontana coronaria (Jacq.) Willd. 'Flore Pleno'	PP10, PPC
Tabernaemontana crassa Benth.	PP18
Tabernaemontana crispa Roxb.	PP10
Tabernaemontana glandulosa (Stapf) Pichon	PP18
Tabernaemontana heterophylla Vahl	PP8
Tabernanthe iboga Baill.	PP18
Thevetia peruviana (Pers.) K.Schum.	PPJ, PPM
Trachelospermum 'Shirofu-Chirimen'	KK3
Trachelospermum asiaticum Nakai	PPA
Trachelospermum jasminoides (Lindl.) Lem.	PPA
Voacanga africana Stapf	PP18
Wrightia natalensis Stapf	PPH
unnamed specimen	PPG

Asclepiadaceae

Asclepias curassavica L.	PP9, PPI, PPJ
Calotropis procera (Ait.) Dryand.	PP10
Caralluma ango (A.Rich.) N.E.Br.	PP1
Caralluma baldratii A.C.White & B.Sloane	PP1
Caralluma burchardii N.E.Br.	PP1
Caralluma burchardii N.E.Br. var. *maura* Maire	PP1
Caralluma dummeri (N.E.Br.) A.C.White & B.Sloane	PP1
Caralluma edulis (Edgew.) Benth. & Hook.	PP1
Caralluma europaea (Guss.) N.E.Br. var. *affinis* (De Wild.) A.Berger	PP1
Caralluma foetida E.A.Bruce	PP1
Caralluma foulcheri-delboscii Lavranos	PP1
Caralluma frerei G.D.Rowley	PP1
Caralluma gracilipes K.Schum.	PP1
Caralluma gracilipes K.Schum. subsp. *arachnoidea* P.R.O.Bally	PP1
Caralluma hesperidum Maire	PP1
Caralluma hottentotorum (N.E.Br.) N.E.Br.	PP1
Caralluma joannis Maire	PP1
Caralluma keithii R.A.Dyer	PP1
Caralluma munbyana (Decne.) N.E.Br.	PP1
Caralluma parviflora (A.Massal.) N.E.Br.	PP1
Caralluma priogonium K.Schum.	PP1
Caralluma schweinfurthii A.Berger	PP1
Caralluma tubiformis E.A.Bruce & P.R.O.Bally	PP1
Caralluma turneri E.A.Bruce	PP1
Ceropegia sp.	PP1
Ceropegia ampliata E.Mey.	PP1
Ceropegia arabica H.Huber	PP1

Ceropegia armandii Rauh	PP1
Ceropegia ballyana Bullock	PP2
Ceropegia barklyi Hook.f.	PP1
Ceropegia denticulata K.Schum. var. *denticulata*	PP1
Ceropegia devecchii Chiov.	PP1
Ceropegia devecchii Chiov. var. *adelaidae* P.R.O.Bally	PP1
Ceropegia dichotoma Haw.	PP1
Ceropegia distincta N.E.Br. subsp. *haygarthii* (Schltr.) H.Huber	PP1
Ceropegia evelynae E.A.Bruce	PP1
Ceropegia fusca Bolle	PP1
Ceropegia fusiformis N.E.Br.	PP1
Ceropegia grandis E.A.Bruce	PP1
Ceropegia hians Svent.	PP1
Ceropegia juncea Roxb.	PP1
Ceropegia krainzii Svent.	PP1
Ceropegia linearis E.Mey.	PP1
Ceropegia nilotica Kotschy	PP1
Ceropegia nilotica Kotschy var. *nilotica*	PP1
Ceropegia radicans Schltr.	PP1
Ceropegia robynsiana Werderm.	PP1, PP2
Ceropegia x *rothii* Gürke	PP1
Ceropegia sandersonii Decne. ex Hook.f.	PP1, PP2
Ceropegia stapeliiformis Haw.	PP1, PPH
Ceropegia succulenta E.A.Bruce	PP1
Ceropegia variegata N.E.Br.	PP1
Ceropegia woodii Schltr.	PP1
Ceropegia woodii Schltr. x *barklyi* Hook.f.	PP1
Ceropegia woodii Schltr. subsp. *debilis* (N.E.Br.) H.Huber	PP1
Ceropegia woodii Schltr. subsp. *woodii*	PP1, PPH
Cryptostegia grandiflora (Roxb.) R.Br.	PPF, KK19
Cryptostegia madagascariensis Bojer	PP18
Cynanchum marnierianum Rauh	PP22
Decabelone grandiflora K.Schum.	PP1, PP22
Dictyanthus stapeliaeflorus F.Rchb.	PP22
Dischidia bengalensis Colebr.	PPC, PP10
Dischidia pectenoides H.Pearson	PPK, PP10
Duvalia elegans (A.Massal.) Haw.	PP1
Duvalia elegans (A.Massal.) Haw. var. *seminuda* N.E.Br.	PP1
Duvalia reclinata (A.Massal.) Haw.	PP1
Duvaliandra dioscoridis (Lavranos) M.G.Gilbert	PP1
Echidnopsis cereiformis Hook.f.	PP1, PPH
Echidnopsis dammaniana Spreng.	PP1
Echidnopsis radians M.Bellerue-Bleck	PP1
Echidnopsis repens R.A.Dyer & I.Verd.	PP1

Edithcolea sp.	PP1
Edithcolea grandis N.E.Br.	PP1
Fockea sinuata (E.Mey.) Marloth	PP1
Gonolobus niger R.Br.	PP20
Hoodia gordonii (Masson) Sweet	PP1
Hoodia macrantha Dinter	PP1
Hoya sp.	PP10
Hoya angustifolia Trail	PP10
Hoya australis R.Br.	PP1
Hoya carnosa (L.f.) R.Br.	PPC, PP1, PP10
Hoya carnosa (L.f.) R.Br. '---'	PP10
Hoya carnosa (L.f.) R.Br. 'Compacta'	PP1
Hoya carnosa (L.f.) R.Br. 'Exotica'	PP1
Hoya carnosa (L.f.) R.Br. 'Motaskae'	PP1
Hoya carnosa (L.f.) R.Br. 'Variegata'	PP1
Hoya globulosa Hook.f. x *higginsii*	PP1
Hoya imperialis Lindl.	PP10
Hoya linearis Wall.	PP1
Hoya multiflora (Decne.) Blume	PP1, PP10
Hoya obovata Decne.	PP10
Hoya purpureofusca Hook.	PP10
Huernia sp.	PP1
Huernia aspera N.E.Br.	PP1
Huernia boleana Gilbert	PP1
Huernia confusa E.Phillips	PP1
Huernia insigniflora C.A.Maass	PP1
Huernia keniensis R.E.Fr.	PP1
Huernia keniensis R.E.Fr. var. *nairobiensis* A.C.White & B.Sloane	PP1
Huernia keniensis R.E.Fr. var. *quarta*	PP1
Huernia kennedyana Lavranos	PP1
Huernia loeseneriana Schltr.	PP1
Huernia macrocarpa (A.Rich.) Spreng.	PP1
Huernia macrocarpa (A.Rich.) Spreng. var. *penzigii* (N.E.Br.) B.Sloane & A.C.White	PP1
Huernia oculata Hook.f.	PP1
Huernia pendula E.A.Bruce	PP1
Huernia purpusii	PP1
Huernia saudi-arabica D.V.Field	PP1
Huernia schneiderana A.Berger	PP1
Huernia schneiderana A.Berger 'Cristata'	PP1
Huernia striata Oberm.	PP1
Huernia zebrina N.E.Br.	PP1
Matelea trianae (Decne. ex Triana) Spellman	PP1
Ophionella arcuata (N.E.Br.) Bruyns var. *mirkinii* (Pillans) Bruyns	PP1
Orbea ciliata (Thunb.) L.C.Leach	PP1

Orbeopsis gerstneri (Letty) L.C.Leach subsp. *elongata* (R.A.Dyer) L.C.Leach	PP1
Oxypetalum caeruleum (D.Don) Decne.	PP20, PP23
Piaranthus sp.	PP1
Piaranthus foetidus N.E.Br.	PP1
Piaranthus parvulus N.E.Br.	PP1
Piaranthus pulcher N.E.Br.	PP1
Piaranthus ruschii Nel	PP1
Raphionacme welwitschii Schltr. & Rendle	PP22
Sarcostemma sp.	PP1
Sarcostemma stipitaceum Schult.	PP1
Sarcostemma viminale (L.) R.Br.	PP1
Secamone afzelii (Schult.) K.Schum.	PP18
Stapelia sp.	PP1
Stapelia albicans	PP1
Stapelia ambigua A.Massal. var. *fulva* Sweet	PP1
Stapelia arnotii N.E.Br.	PP1
Stapelia desmetiana N.E.Br.	PP1
Stapelia x *discolor* Tod.	PP1
Stapelia erectiflora N.E.Br.	PP1
Stapelia flavirostris N.E.Br.	PP1
Stapelia gemmiflora A.Massal.	PP1
Stapelia gettleffii R.Pott	PP1
Stapelia gigantea N.E.Br.	PP1
Stapelia gigantea N.E.Br. var. *pallida* E.Phillips	PP1
Stapelia glabricaulis N.E.Br.	PP1
Stapelia x *hanburyana* Rüst & A.Berger	PP1
Stapelia hirsuta L. var. *patula* (Willd.) N.E.Br.	PP1
Stapelia lepida Jacq.	PP1
Stapelia longidens N.E.Br.	PP1
Stapelia x *luxurians* Dammann. ex Rüst	PP1
Stapelia nobilis N.E.Br.	PP1
Stapelia pasadenensis A.C.White & B.Sloane	PP1
Stapelia pulchella A.Massal. 'Cristata'	PP1
Stapelia x *rectiflora* Rüst	PP1
Stapelia tsomoensis N.E.Br.	PP1
Stapelia variegata L.	PP1, PPH
Stapelia variegata L. var. *atrata* (Tod.) N.E.Br.	PP1
Stapelia variegata L. var. *marmorata* (Jacq.) N.E.Br.	PP1
Stapelia variegata L. var. *pallida* N.E.Br.	PP1
Stapelia variegata L. var. *picta* (Donn) N.E.Br.	PP1
Stapelia variegata L. var. *planiflora* (Jacq.) N.E.Br.	PP1
Stapelia variegata L. var. *trisulca* (Donn) N.E.Br.	PP1
Stapelia variegata L. var. *variegata*	PP22
Stapelia wilmaniae C.A.Lückh.	PP1, PPH

Stapelianthus decaryi Choux	PP1
Stapelianthus keraudreniae Bosser & Morat	PP1
Stephanotis floribunda Brongn.	PPG
Trichocaulon sp.	PP22
Trichocaulon clavatum (Willd.) H.Huber	PP1
Trichocaulon dinteri A.Berger	PP22
Tridentea longipes (C.A.Lückh.) L.C.Leach	PP1
Tridentea marientalensis (Nel) L.C.Leach	PP1
Tylophora laevigata Decne.	PP18

Gentianaceae

Irlbachia sp.	KK18

Loganiaceae

Gelsemium sempervirens (L.) Aiton	PP20
Strychnos congolana Gilg	PPF
Strychnos madagascariensis Poir.	PP18
Strychnos millepunctata Leeuwenb.	PP18
Strychnos nux-vomica L.	PP10
Strychnos potatorum L.f.	PP18
Strychnos schultesiana Krukoff	PPM
Strychnos spinosa Lam.	PPJ, PP18

Rubiaceae

Aidia micrantha (K.Schum.) Bullock ex F.White	PP18
Bouvardia 'Alba'	PPI, PP20
Bouvardia 'Rosea'	PP20
Bouvardia 'Rubra'	PP20
Bouvardia ternifolia (Cav.) Schltdl.	PP20
Catunaregam spinosa (Thunb.) Tirveng.	PPD, PP18
Cephaelis ipecacuanha (Brot.) Tussac	KK18
Chassalia sp.	KK9
Cinchona pubescens Vahl	PPJ, PPM
Coccocypselum guianense (Aubl.) K.Schum.	PP9, KK19
Coffea arabica L.	PPG, PPJ
Coffea arabica L. 'Catura'	PPJ
Coffea arabica L. 'Catura'	PP18
Coffea arabica L. 'de Miberisi'	PPJ
Coffea arabica L. 'La Jamaica'	PPJ
Coffea arabica L. 'Minima'	PP18

Coffea arabica L. 'Nana'	PPJ, PP18
Coffea arabica L. 'Polysperma'	PPG
Coffea arabica L. 'Sans Ramon'	PPJ
Coffea arabica L. 'Violette'	PPJ
Coffea arabica L. var. *abyssinica* A.Chev.	PPG
Coffea x *arabusta* Capot & Aké Assi	PPJ
Coffea arnoldiana De Wild.	PPG, PPJ
Coffea aruwimiensis De Wild.	PPG
Coffea canephora Pierre & A.Froehner	PPG, PPJ
Coffea canephora Pierre & A.Froehner var. *kouilouensis* Pierre	PPG
Coffea canephora Pierre & A.Froehner var. *sankuruensis* De Wild.	PPG
Coffea dewevrei De Wild. & T.Durand	PPG
Coffea dybowskii Pierre	PPG
Coffea excelsa A.Chev.	PPG
Coffea laurifolia Salisb.	PP18
Coffea liberica W.Bull ex Hiern	PPG
Coffea liberica W.Bull ex Hiern var. *dewevrei* (De Wild. & T.Durand) Lebrun	PPG
Coffea liberica W.Bull ex Hiern var. *liberica*	PPG
Coffea mauritiana Lam.	PPG
Coffea myrtifolia Roxb.	PPG
Coffea racemosa Lour.	PPG
Coprosma 'Coppershine'	PP5, PPA, KK17
Coprosma baueri Endl.	PPA
Coprosma baueri Endl. 'Picturata'	PPA
Coprosma kirkii Cheeseman 'Variegata'	PP5, KK7
Coprosma repens Hook.f.	PP5
Cremaspora triflora (Thonn.) K.Schum.	PP18
Didymosalpinx norae (Swynn.) Keay	PP18
Duperrea pavettaefolia Pit.	PPD, KK18
Emmenopterys henryi Oliv.	PP5
Euclinia longiflora Salisb.	PPF, PPK
Feretia aeruginescens Stapf	PP18
Fernelia buxifolia Lam.	PP18
Galium hypocarpium (L.) Endl. ex Griseb.	KK3
Gardenia cornuta Hemsl.	PPH, PP20
Gardenia spathulifolia Stapf & Hutch.	PP20
Gardenia ternifolia Schumach. & Thonn. subsp. *ternifolia*	KK18
Gardenia thunbergia L.f.	PPH, PPL, PP20
Genipa americana L.	PPM
Geophila macropoda (Ruiz & Pav.) DC.	PP9
Geophila repens (L.) J.M.Johnst.	PP9
Guettarda uruguensis Cham. & Schltdl.	PPM
Hamelia patens Jacq.	PPM
Hamelia versicolor A.Gray ex S.Watson	PP8

Hillia parasitica Jacq.	KK18
Hoffmannia ghiesbreghtii Hemsl.	PP9, PPE, KK19
Hoffmannia ghiesbreghtii Hemsl. 'Variegata'	PP9, PPM
Hoffmannia refulgens (Hook.) Hemsl.	PP9, PPK
Hoffmannia regalis (Hook.) Hemsl.	PP9, PPK, PPM
Hydnophytum formicarum Jack	PPK, PP17
Ixora sp.	PP10
Ixora (Coccinea-hybrid) 'Calycifolia'	PPD
Ixora (Coccinea-hybrid) 'Shawii'	KK19
Ixora chinensis Lam.	PPK, PP10, KK19
Ixora chinensis Lam. 'Alba'	PPD
Ixora chinensis Lam. 'Rosea'	PPK, PP10
Ixora coccinea L.	PP10
Ixora lutea Hutch.	PP10
Keetia multiflora (Schumach. & Thonn.) Bridson	KK18
Leptactina leopoldi-secundi Büttner	KK7
Leptactina pynaertii De Wild.	KK7
Luculia gratissima Sweet x *tsetensis*	PP5
Massularia acuminata (G.Don) Bullock ex Hoyle	PPG
Mitragyna rubrostipulata (K.Schum.) Havil.	PPF
Mitriostigma axillare Hochst.	PPH, PP20
Morinda sp.	PP18
Morinda citrifolia L.	PP10
Morinda lucida Benth.	PP10
Mussaenda erythrophylla Schumach. & Thonn.	PP18
Myrmecodia armata DC.	PPK, PP17
Myrmecodia echinata Miq.	PPK, PP17
Nertera cunninghamii Hook.f.	PP5
Nertera granadensis (Mutis ex L.f.) Druce	PP20
Nertera cf. *granadensis* (Mutis ex L.f.) Druce	KK3
Oxyanthus formosus Hook.f.	PPF, PP18
Oxyanthus racemosus (K.Schum. & Thonn.) Keay	PPG
Paederia sp.	KK9
Paederia foetida L.	PP10
Pavetta abyssinica Fresen.	PPH
Pentas lanceolata (Forssk.) Deflers	PPF, KK17
Pentas lanceolata (Forssk.) Deflers '---' (pink 1)	KK17
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Posoqueria longiflora Aubl.	KK18
Pouchetia baumanniana Büttner	PP18
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Psychotria brasiliensis Vell.	PPE, PPM
Psychotria calva Hiern	PPF
Psychotria carthagenensis Jacq.	PP8
Psychotria kirkii Hiern	PP18
Psychotria kirkii Hiern var. *tarambassica* (Bremek.) Verdc.	PPF
Psychotria lucens Hiern var. *lucens*	PPF
Psychotria maingayi Hook.f.	PPC, PP10
Psychotria nigropunctata Hiern	PP18
Psychotria peduncularis (Salisb.) Steyerm.	PPG
Psychotria uliginosa Sw.	KK1
Psychotria verschuerenii De Wild. var. *reducta* E.M.A.Petit	PP18
Randia nitida (Humb., Bonpl. & Kunth) DC.	PPJ
Rondeletia odorata Jacq.	PP9, PPE, PPM
Rosenbergiodendron formosum (Jacq.) Fagerl.	PP8
Rothmannia fischeri (K.Schum.) Bullock	PPF
Rothmannia manganjae (Hiern) Keay	PP18
Rudgea macrophylla Benth.	PP9
Schumanniophyton magnificum (K.Schum.) Harms	PPF
Serissa foetida (L.f.) Lam. '---'	PP10
Tarenna borbonica (Hend. & A.Hend.) Verdc.	PP18
Tocoyena guianensis K.Schum.	KK1
Tricalysia junodii (Schinz) Brenan var. *kirkii* (Hook.f.) Robbr.	KK17
Vangueria edulis Vahl	PPF, PPJ
Vangueria infausta Burch.	PPF
Vangueria infausta Burch. var. *virescens* Sond.	PP18
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E. Robbrecht, E. Smets & C. Puff (eds.)

Second International Rubiaceae Conference (13-15 September 1995), Programme and abstracts

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